

DESCRIPTION

Invention Title: SMART LOGISTICS VEHICLE CONTROL METHOD AND CONTROL DEVICE

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Technical Field

[1] The present disclosure relates to a smart logistics vehicle control method and a control device that provide a movement path such that a smart logistics vehicle can move from a departure point to a selected destination.

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[2]

Background Art

[3] In recent years, smart logistics vehicles have been introduced for flexible and efficient supply and transport of components and the like, not only in general logistics warehouses and factories, but also in smart factories that manufacture goods with specifications different from each other using various components.

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[4] A smart logistics vehicle is a concept collectively referring to an autonomous mobile robot (AMR) and an automated guided vehicle (AGV), and such a smart logistics vehicle can perform movements and operations under the control of a control system.

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[5] For example, when the smart logistics vehicle performs a mission from a departure point to a destination, a control system may generate a movement path that connects the departure point and an accessible destination by determining situations of the destination. Also, the control system may control the smart logistics vehicle to perform the mission from the departure point to the destination based on the generated movement path.

[6] However, even when the destination is determined to be accessible at the time of generating the movement path, the destination may change to be inaccessible due to other smart logistics vehicles or process conditions while the smart logistics vehicle is moving. In this case, the smart logistics vehicle arriving at the destination according to the existing mission may be unable to enter the destination and thus fail to fully perform the existing mission, such that a deadlock with other smart logistics vehicles occurs near the destination because of the smart logistics vehicle not entering the destination and remaining in the vicinity of the destination.

[7] In addition, when the destination is initially determined to be in an inaccessible state at the time of generating the movement path, the movement path may not be generated or another accessible destination may be determined to generate the movement path. In this case, the initially determined

destination may change to be in an accessible state, but even when changing to be in an accessible state, a problem may occur in which the smart logistics vehicle remains in a standby state at the departure point due to the prior inaccessibility to the initially determined destination, or moves to another destination different from the initially determined destination.

[8] Accordingly, it is necessary to present a solution to perform the existing mission even when the situation of the destination changes while the smart logistics vehicle moves along the movement path connecting the departure point and the destination.

[9]

[10] The matters described above as the background technology are only intended to enhance an understanding of the background of the present disclosure, and should not be construed as acknowledging that it corresponds to the prior art already known to those skilled in the art.

[11]

Disclosure

Technical Problem

[12] The present disclosure is proposed to solve such a problem, and is intended to provide a smart logistics vehicle control method and a control device, capable of determining in advance

whether a destination is accessible while a smart logistics vehicle moves from a departure point to a selected destination.

[13]

[14] Technical tasks to be achieved by the present disclosure are not limited to the technical tasks mentioned above, and other technical tasks not mentioned may be clearly understood by those skilled in the art to which the present disclosure belongs from the following description.

[15]

Technical Solution

[16] A smart logistics vehicle control method according to the present disclosure for achieving the above objective includes controlling at least one smart logistics vehicle to move toward a destination confirmation location corresponding to a plurality of candidate destinations related to a currently assigned mission, determining whether at least one of the plurality of candidate destinations is accessible when entering the destination confirmation location while the at least one smart logistics vehicle is moving, and setting an accessible candidate destination among the plurality of candidate destinations as a final destination.

[17]

[18] In addition, a control device according to the present disclosure for achieving the above objective includes a

communication unit for communicating with at least one smart logistics vehicle, and a path selection unit for controlling the at least one smart logistics vehicle to move toward a destination confirmation location corresponding to a plurality of candidate destinations related to a currently assigned mission, for determining whether at least one of the plurality of candidate destinations is accessible when entering the destination confirmation location while the at least one smart logistics vehicle is moving, and for setting an accessible candidate destination among the plurality of candidate destinations as a final destination.

[19]

Advantageous Effects

[20] As described above, a smart logistics vehicle control method and a control device of the present disclosure can determine whether a predetermined destination is accessible while a smart logistics vehicle is moving from a departure point to the predetermined destination and, when the predetermined destination is inaccessible, can change the destination to another destination that is accessible and that performs the same mission, thereby smoothly performing a mission previously assigned to the smart logistics vehicle.

[21]

[22] The effects obtainable from the present disclosure are not limited to the effects mentioned above, and other effects not mentioned will be clearly understood by those skilled in the art to which the present disclosure belongs from the description below.

[23]

Description of Drawings

[24] FIG. 1 is a block diagram illustrating an example of a smart factory configuration applicable to exemplary embodiments of the present disclosure.

[25] FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to exemplary embodiments of the present disclosure.

[26] FIG. 3 is a block diagram illustrating an example of a smart logistics vehicle configuration applicable to exemplary embodiments of the present disclosure.

[27] FIG. 4 is a perspective view illustrating an example of an exterior appearance of a smart logistics vehicle applicable to exemplary embodiments of the present disclosure.

[28] FIG. 5 is a flowchart illustrating an example of a travelling process of a smart logistics vehicle applicable to exemplary embodiments of the present disclosure.

[29] FIG. 6 is a block diagram illustrating an operation of a control device according to an exemplary embodiment of the present disclosure.

[30] FIG. 7 is a view illustrating a situation of determining a candidate destination of a smart logistics vehicle according to an exemplary embodiment of the present disclosure.

[31] FIG. 8 is a view illustrating a smart logistics vehicle control method according to an exemplary embodiment of the present disclosure.

[32]

Mode for Invention

[33] In describing an exemplary embodiment disclosed in the present specification, the detailed description thereof may be omitted when it is determined that a detailed description of the related known technology may obscure the gist of the exemplary embodiment disclosed in the present specification. In addition, the accompanying drawings may be only intended to facilitate the understanding of the exemplary embodiment disclosed in the present specification, and the technical idea disclosed in the present specification may not be limited by the accompanying drawings and it should be understood to include all modifications, equivalents, or substitutes included in the spirit and technical scope of the present disclosure.

5 **[34]** Terms including ordinal numbers, such as a first and a second, may be used to describe various components, but the components may not be limited by the terms. The terms may be used only for the purpose of distinguishing one component from another component.

10 **[35]** When it is mentioned that a component is "connected" or "linked" to another component, it should be understood that the component may be directly connected or linked to the other component, but another component may be interposed therebetween. On the other hand, when it is mentioned that a component is "directly connected" or "directly linked" to another component, it should be understood that no other component exists in the middle.

15 **[36]** Singular expressions may include plural expressions unless the context clearly indicates otherwise.

20 **[37]** In the present specification, the terms such as "include" or "have" may be intended to specify the existence of features, numbers, steps, operations, components, parts, or combinations thereof described in the specification, which should be understood not to preclude the existence or addition of one or more other features, numbers, steps, operations, components, parts, or combinations thereof.

25 **[38]** Hereinafter, an exemplary embodiment disclosed in the present specification will be described in detail with reference to the accompanying drawings, but identical or

similar components will be assigned the same reference numbers regardless of the drawing codes, and redundant descriptions thereof will be omitted.

[39] In addition, the terms, such as unit or control unit included in the names of internal configurations of a smart logistics vehicle or a control device may be merely terms widely used to refer to a controller for controlling specific functions and do not refer to a generic function unit. For example, in order to control functions in charge, each controller may include a modem/transceiver for communicating with other control devices or sensors, a memory for storing operating systems or logic commands and input/output information, and one or more processors for performing determination, calculation, and decision necessary to control functions in charge. Depending on implementations, one processor may be in charge of calculations for a plurality of control devices.

[40]

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

[42] FIG. 1 is a block diagram illustrating an example of a smart factory configuration applicable to exemplary embodiments of the present disclosure.

[43] Referring to FIG. 1, a smart factory 100 may include a smart logistics vehicle 110, a production device 120, an inspection device 130, and a control device 140.

[44] The smart factory 100 may be provided with a plurality of smart logistics vehicles 110, a plurality of production devices 120, and a plurality of inspection devices 130 according to a production process of a product and a target production speed. Hereinafter, each component will be described.

[45] First, the smart logistics vehicle 110 may include an autonomous mobile robot (hereinafter, referred to as an "AMR" for convenience) and an automated guided vehicle (hereinafter, referred to as an "AGV" for convenience). According to an operation policy of the smart logistics vehicle 110, only one type of either the AGV or the AMR may be operated within the smart factory 100, or both the AGV and the AMR may be operated together within a single smart factory 100.

[46] The AGV may generally perform the operations (movement, direction change, stop, etc.) required within the smart factory 100 by recognizing and following a guide facility arranged on the floor for guiding the AGV. Herein, the guide facility may refer to optically recognizable markers (spots, 2D codes, etc.), tags recognizable in a non-contact manner at a short distance (e.g., NFC tags, RFID tags, etc.), magnetic strips, wires, and the like, but this is illustrative and is

not necessarily limited thereto. The guide facility may be arranged continuously on the floor or may be arranged to be discontinuously spaced apart from each other. Since the AGV basically performs operations by recognizing and following the guide facility, it is required that the guiding facility be installed in advance before operation, and it is necessary to physically establish or modify the guide facility when moving the AGV to a new path or modifying the existing path. In addition, the AGV may not deviate from the path set through the guide facility, so it is common for the AGV to stop when an obstacle is detected on or around the path until the detected obstacle is removed or separate control is provided. In the operation of the AGV, the control device 140 should control the AGV based on the guide facility, so may transmit the commands such as "travelling until the third marker is recognized" and "switching the heading direction by 90 degrees when the third marker is recognized" to the AGV either as an individual command unit or as a mission unit (e.g., retrieval, supply, charge, patrol, etc.) including a plurality of commands.

[47] The AMR may determine the current location (i.e., positioning) by detecting the surroundings, and the point, at which path planning is possible by using positioning and a map, may be the most distinguishing point from the AGV. Therefore, when the AMR and the control device 140 share a map in which

coordinates are compatible with each other, the control device 140 may control the AMR in a manner of instructing the AMR a path based on the coordinates. In addition, when detecting an obstacle while travelling, the AMR may set an avoidance path on its own, avoid the obstacle, and return to the existing path. A function in which the control device 140 sets a path of the AMR with one or more waypoint coordinates may be referred to as global path planning, and a function in which the AMR sets a movement path or an avoidance path between the waypoint coordinates according to the global path planning may be referred to as local path planning.

[48] A more detailed configuration of the smart logistics vehicle 110 will be described later with reference to FIGS. 3 and 4, and a travelling control process of the AMR will be described later with reference to FIG. 5, respectively.

[49] Next, the production device 120 may refer to a device (e.g., robot arm, conveyor belt, etc.) that performs the production process of the product in the smart factory 100 and, in a broader sense, may refer to a device arranged to assist in performing missions such as entry and exit of the smart logistics vehicle 110 when the production process is performed by a person. The device arranged to assist in performing missions may be a device for detecting the state of a designated location where a pallet carried by the smart logistics vehicle 110 can be put down or collected within a

zone where a specific production process is performed, a device for determining the degree of the process progress, and a means for blocking entry and exit within a zone, etc., but is not necessarily limited thereto.

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

10 **[51]** The inspection device 130 may perform a function of obtaining information for determining a situation within the smart factory 100 and transmitting the same to the control device 140. For example, the inspection device 130 may include a camera, a proximity sensor, and the like, but is not necessarily limited thereto.

15 **[52]** The control device 140 may communicate with the aforementioned components 110, 120, 130 to obtain information necessary to operate the smart factory 100 or control each component. For example, the control device 140 may perform dispatching, path setting, mission assignment, process
20 management per product, material management, and the like of the smart logistics vehicle 110.

25 **[53]** In implementations, the control device 140 may include a local control device (ACS: AMR/AGV Control System) for controlling surrounding process facilities based on the locations of the AGVs/AMRs and performing mission-based

control of the AGVs/AMRs, and an integrated control device (MoRIMS: Mobile Robot Integrated Monitoring System) for integrating and controlling two or more local control devices. The integrated control device may perform the state and path, logistics flow setting, and traffic control of all smart logistics robots 110 within the smart factory 100 from each of the plurality of local control devices. For example, when the local control device (ACS) is provided with a smart logistics robot unit of the same manufacturer or the same model, the integrated control device may perform integrated control for collision prevention, such as analysis of bottleneck levels in intersection/overlapping areas, travelling acceleration /deceleration control, and regeneration of avoidance path, through heterogeneous traffic distribution control based on information obtained through the plurality of local control devices (ACS).

[54] Further, the integrated control device may have a manufacturing execution system (MES) as a higher-level control entity, and the manufacturing execution system (MES) may be again linked to the advanced planning & scheduling (APS).

[55] In addition to the configurations 110, 120, 130, 140 of the aforementioned smart factory 100, it is obvious that a device for intercommunication between components such as beacons, repeaters, or APs (Access Point), a charger for charging the smart logistics vehicle 110, a loading space for storing or

loading parts, a space for storing finished products or intermediate products, traffic lights, breakers, and a waiting space for idle smart logistics vehicles 110 can be properly arranged within the smart factory 100.

5 **[56]** Hereinafter, a configuration of the control device 140 applicable to exemplary embodiments of the present disclosure will be described with reference to FIG. 2.

10 **[57]** FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to exemplary embodiments of the present disclosure. Each component shown in FIG. 2 may mainly show components in relation to exemplary embodiments of the present disclosure, and more or fewer components may be included in the actual implementation of the control device 140.

15 **[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.

20 **[59]** The firmware management unit 141 may obtain the latest firmware of the smart logistics vehicle 110 through the communication unit 146 and transmit the same to the smart logistics vehicle 110 to perform a firmware update, thereby

maintaining the firmware of the smart logistics vehicle 110 up to date.

[60] The traffic control unit 142 may control the traffic light and the breaker based on the path of the smart logistics vehicle 110, and may recalculate the path of the smart logistics vehicle 110 according to traffic.

[61] The process management unit 143 may define a process for each product and may manage missions such as the degree of the process progress and a progress location.

[62] The production/logistics management unit 144 may dispatch the smart logistics vehicle 110 on a mission basis.

[63] The inventory management unit 145 may manage the location and quantity for each material, and this information may be useful for more efficient process operation, such as allowing the smart logistics vehicle 110 to depart for a destination in advance for pallet pickup or retrieval before the actual assembly or consumption of the materials is detected.

[64] The communication unit 146 may perform communication with internal components of the smart factory 100, such as the smart logistics vehicle 110, the production device 120, and the inspection device 130, as well as external entities, such as a firmware update server.

[65] The vehicle monitoring unit 147 may monitor the location, path, battery state, communication state, power train state, and the like of the individual smart logistics vehicle 110.

Herein, the path may be a concept including a waypoint-based global path and a real-time local path. In addition, the battery state may include voltage, current, temperature, peak values of voltage and current, state of charge (SOC), state of health (SOH), and the like. The communication state may include information about a currently activated communication protocol (such as Wi-Fi), a connected AP, a distance to the AP, a channel in use, and the like. Further, the power train state may include a load, temperature, RPM, and the like of the drive system.

[66] Besides, the vehicle monitoring unit 147 may identify the mission, operation mode, firmware version, and the like currently assigned to the individual smart logistics vehicle 110.

[67] The map management unit 148 may obtain map data in the form of a grid map obtained by the AMR among the smart logistics vehicles 110 while travelling inside the smart factory 100, and provide a tool for a factory manager to edit the obtained map data. Through the editing of the map data, zones for performing one or more preset operations when the smart logistics vehicle 110 enters, virtual lanes, intersections, and entry-restricted zones may be set, but this is illustrative and is not necessarily limited thereto. In addition, the map management unit 148 may distribute through the communication unit 146 the corresponding map to the rest of the smart

logistics vehicles 110 other than the smart logistics vehicle 110 that obtains the initial grid map through actual travelling.

[68] Next, a smart logistics vehicle will be described with reference to FIGS. 3 and 4.

5 **[69]** FIG. 3 is a block diagram illustrating an example of a smart logistics vehicle configuration applicable to exemplary embodiments of the present disclosure.

[70] Referring to FIG. 3, the smart logistics vehicle 110 may include a traveling unit 111, a sensing unit 112, a loading
10 unit 113, a communication unit 114, and a control unit 115. Hereinafter, each component will be described.

[71] The traveling unit 111 may include a driving source, a wheel, a suspension, and the like, which are involved in the movement, steering, and stopping of the smart logistics vehicle 110. The
15 driving source may utilize an electric motor supplied with power from a built-in battery (not shown). The wheel may include one or more driving wheels supplied with driving force from the driving source, and a non-driving wheel that rotates by the movement of the vehicle body without receiving the
20 driving force. Depending on the implementations, the rotation of each driving wheel may be independently controlled when a plurality of driving wheels are provided and the driving source is matched for each driving wheel. In this case, by varying the rotation directions of driving wheels different from each
25 other, the steering may be performed without a separate

steering means by rotating the vehicle body. At least some of the non-driving wheels may be configured as caster-type wheels, but this is illustrative and is not necessarily limited thereto.

[72] The sensing unit 112 may be for sensing the surrounding environment of the smart logistics vehicle 110 or the state of its own operations, 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 encoder, and a proximity sensor.

[73] The encoder may output information for determining how much the wheel is rotated by using light emitted from a light emitting element (e.g., a photodiode). For example, the encoder may count the number of slits disposed along the circumferential direction on the wheel or the disk rotating together with the wheel for a unit time. The control unit 115 may perform odometry to estimate a displacement by analyzing the amount of location change with respect to time by using data obtained through the encoder and the gyro sensor. However, a displacement estimated based on the encoder data may have an error from the actual displacement due to wheel slip or wear (a change in the wheel dynamic diameter). Therefore, when performing the odometry, the control unit 115 may perform correction for noise and error on the information collected from the wheel and gyro sensors using a predetermined algorithm (e.g., EKF: Extended Kalman Filter), thereby outputting a

result that tends to be close to an actual value. Such odometry may be particularly useful when it is impossible to determine the current location (localization) using a 2D laser scanner to be described later.

5 **[74]** The 2D laser scanner may scan the surrounding environment by radiating a laser beam to the surroundings through a rotating reflector and sensing a reflected and returned signal. In this case, a detection result in the form of a point cloud may be output by analyzing the intensity of the reflected
10 signal and a time difference between radiation and reception.

[75] The 3D vision camera may calculate a distance to the object based on a parallax between two cameras spaced apart as much as a predetermined distance, that is, a pixel distance between images captured by each camera. In this case, a texture
15 projector that projects infrared light of a predetermined pattern may be provided so that a flat object of the same color (e.g., a white wall), and the like can be detected.

[76] In general, 2D laser scanners may be used for mapping, navigation, object recognition, etc., and 3D cameras may be
20 used especially for avoiding obstacles during navigation, but this is illustrative and is not necessarily limited.

[77] The loading unit 113 may be a means for loading the item to be transported, and may be in the form of a top plate itself on the upper part of the vehicle body or a table disposed on
25 the top plate, a lift, a turntable rotating along a vertical

axis, a fork lift, a conveyor, or a combination thereof. In the case of the fork lift, it may support telescopic and tilting functions, like a forklift.

[78] The communication unit 114 may communicate with other components in the smart factory 100, such as the production device 120 and the control device 140, may support communication between the smart logistics vehicles 110, and may communicate with the charger when performing a charging mission.

[79] The control unit 115 may be the entity that performs overall control of each of the aforementioned components 111, 112, 113, 114, and may perform a current mission, a current location, a destination determination, path planning, a control of the loading unit, and the like based on the information obtained from the control device 140 through the communication unit 114.

[80] FIG. 4 is a perspective view illustrating an example of an exterior appearance of a smart logistics vehicle applicable to exemplary embodiments of the present disclosure.

[81] Referring to FIG. 4, an example of AMR may be illustrated as a smart logistics vehicle 110. The vehicle body may have a track-type planar shape with a long axis extending along the first axis direction as a whole. One driving wheel 111-1 may be disposed in the center portion of the vehicle body in the first axis direction, may be disposed at one side in a second axis direction, and another driving wheel (not shown) may be

disposed at the other side to face one driving wheel 111-1 in the second axis direction. Such an arrangement of driving wheels may be referred to as a differential drive (DD). Although not shown in FIG. 4, two or more non-driving wheels may be disposed at a lower part of the vehicle body. In this case, when two driving wheels rotate at the same speed in the same direction, it is possible to move forward or backward along the first axis direction, and when rotating at the same speed in opposite directions, it is possible to rotate based on a rotation axis that extends along the third axis direction and that passes through a plane center (C) of the vehicle body. In addition, the sensing unit 112 may be disposed at the front surface of the vehicle body, and the loading unit 113 may be disposed at the upper surface. The loading unit 113 may be configured to be elevated along the third axis direction, and a rack, a tray, or the like may be fixed to the upper surface through a guide 113-1.

[82] However, the AMR form of FIG. 4 described above is illustrative, and it is obvious that the AGV may have a form similar to this or the AMR may have a form different from this.

[83] Next, a travelling process of the smart logistics vehicle 110 will be described with reference to FIG. 5.

[84] FIG. 5 is a flowchart illustrating an example of a travelling process of a smart logistics vehicle 110 applicable exemplary embodiments of the present disclosure. In FIG. 5,

it is assumed for convenience that the smart logistics vehicle 110 is an AMR capable of positioning and a local path setting.

[85] Referring to FIG. 5, first, the AMR may obtain a ground-truth grid map through a LiDAR or the like while travelling inside the smart factory 100 (S501).

[86]

[87] When the *AMR transmits the obtained grid map to the control device 140, a grid map editing and matching process may be performed in the map management unit 148 of the control device 140 (S502). Herein, the editing process may include a process of setting the aforementioned various zones on the aforementioned grid map, a process of assigning a cost for each grid, and the like. Herein, the assignment of the cost may be performed in such a way of assigning a higher cost as moving closer to the obstacle or the entry-restricted zone in order to prevent the AMR from moving around the obstacle or to the zone not to enter. This is because the AMR selects the set of cells having the lowest cost among the waypoints as a path in setting the local path.

[88] In addition, the map matching process may refer to a process of matching coordinates between the CAD map used in the design of the smart factory 100, the ground-truth grid map (LiDAR map), and the topology map that undergoes through the editing process.

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

[90] A subsequent step may be a process applied to an individual AMR.

[91] The AMR may determine the current location on the map through the sensor data of the sensing unit 112 and the obtained map (S504). For example, the AMR may determine the current location by comparing the surrounding terrain obtained through the LiDAR with the map based on the feature points.

[92] The control device 140 may select a specific AMR to assign a mission, and in general, one or more waypoints determined through the global path planning may be assigned to the mission. The waypoint may be defined as coordinates on the map, and information about the direction (i.e., heading), which the AMR should be directed at, may be accompanied at the corresponding coordinates. According to the assignment of the mission, a destination may be set in the AMR (Yes in S505), and the AMR may perform the local path planning between waypoints based on the cost of the topology map (S506).

[93] When the path is determined, the AMR may start travelling (S507), and when an obstacle is detected through the sensing unit 112 during travelling (Yes of S508), an avoidance maneuver may be performed by performing a local path searching in order to bypass the detected obstacle (S509). In some cases, the

control device 140 may update the mission of the corresponding AMR according to the avoidance maneuver or according to the failure of the avoidance maneuver.

5 **[94]** In addition, the AMR may correct the location error during the movement through the aforementioned odometry technique while travelling until arriving at the destination (S510).

10 **[95]** Then, when arriving at the destination (S511), the AMR may perform a mission-based maneuver (S512). For example, the AMR may determine whether a condition for entering a specific process area is clear, retrieve an empty pallet from the destination, or drop a loaded load on the loading unit 113.

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15 **[97]** In an exemplary embodiment of the present disclosure, an objective may be to determine in advance whether the destination is accessible while the smart logistics vehicle moves from a departure point to a selected destination.

[98] Hereinafter, an operation of the control device 140 according to an exemplary embodiment of the present disclosure will be described with reference to FIG. 6.

20 **[99]** FIG. 6 is a block diagram illustrating an operation of a control device according to an exemplary embodiment of the present disclosure.

25 **[100]** Referring to FIG. 6, the control device 140 according to an exemplary embodiment of the present disclosure may include a communication unit 146, a map management unit 148, and a path

selection unit 149. FIG. 6 may mainly show components related to an exemplary embodiment of the present disclosure, and in implementing the actual control device 140, it is obvious that more components may be included as described above in FIG. 2.

5 **[101]** In addition, for convenience of explanation, FIG. 6 describes a case in which one control device 140 and one smart logistics vehicle 110 are provided, but it should be understood that this applies equally to a case in which a plurality of smart logistics vehicles and a plurality of control devices
10 are provided.

[102] Hereinafter, each component will be described.

[103] First, the communication unit 146 may communicate with at least one smart logistics vehicle 110 provided in the operation boundary 100. In particular, the communication unit 146 may
15 communicate with the communication unit 114 of the at least one smart logistics vehicle 110, thereby receiving information including a location of the at least one smart logistics vehicle 110, whether to perform a task, and the like. Also, the communication unit 146 may transmit the information
20 generated by the control device 140 to the communication unit 114 of the at least one smart logistics vehicle 110.

[104] The map management unit 148 may set a destination confirmation location for at least a portion within an operation boundary. In this case, the destination confirmation
25 location may be a location at which at least one smart

logistics vehicle 110 can determine whether the destination is accessible while moving. For example, it may be a location for determining whether a plurality of candidate destinations related to a mission currently assigned to the at least one smart logistics vehicle 110 is accessible and, in this case, it may be set to correspond to the plurality of candidate destinations. However, this is illustrative and is not necessarily limited thereto.

[105] Also, the destination confirmation location may be set to correspond to at least one of a node, a zone, and a lane existing on the movement path of the at least one smart logistics vehicle 110. That is, the map management unit 148 may set the destination confirmation location formed of at least one of a node, a zone, and a lane with respect to at least a portion within the operation boundary.

[106] Also, the map management unit 148 may provide information about the set destination confirmation location to the path selection unit 149.

[107] The path selection unit 149 may control at least one smart logistics vehicle 110 to move toward the destination confirmation location.

[108] Specifically, the path selection unit 149 may collect information about the current location of at least one smart logistics vehicle 110, and may set the current location as a departure point and generate a movement path from the departure

point to a destination confirmation location set by the map management unit 148 based on the collected information. However, this is illustrative, and is not necessarily limited thereto. For example, the path selection unit 149 may generate the movement path connecting the departure point and the destination by setting the current location of at least one smart logistics vehicle 110 as the departure point and setting the plurality of candidate destinations related to the mission of at least one smart logistics vehicle 110 as the destination, and in this case, the movement path may be generated such that the destination confirmation location is formed on the movement path in consideration of the destination confirmation location set by the map management unit 148.

[109] The path selection unit 149 may transmit the generated movement path to the communication unit 114 of the at least one smart logistics vehicle 110, and for example, information about a plurality of waypoints included in the movement path may be transmitted to the communication unit 114 of the at least one smart logistics vehicle 110. The at least one smart logistics vehicle 110 may move from the departure point to the destination confirmation location based on the received information about the plurality of waypoints. However, this is illustrative, and is not necessarily limited thereto.

[110] At least one smart logistics vehicle 110 may move from the departure point to the destination confirmation location while

recognizing the plurality of waypoints. In particular, the path selection unit 149 according to an exemplary embodiment of the present disclosure may determine whether at least one of the plurality of candidate destinations is accessible when entering the destination confirmation location while at least one smart logistics vehicle 110 is moving, and can set an accessible candidate destination among the plurality of candidate destinations as the final destination. This will be described in detail with reference to FIG. 7.

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[112] FIG. 7 is a view illustrating a situation of determining a candidate destination of a smart logistics vehicle according to an exemplary embodiment of the present disclosure.

[113] Referring to FIG. 7, a virtual lane (e.g., lane) may be set within an operation boundary 100, and the path selection unit 149 may generate the movement path based on the virtual lane (lane). In FIG. 7, it is assumed that the movement path is generated for a collection mission of any one smart logistics vehicle 110. However, this is illustrative, and is not necessarily limited thereto. In addition, in FIG. 7, it is assumed that the destination confirmation section is formed of one node, but this is illustrative, and it is obvious to be formed based on a zone on the movement path or based on a lane.

[114] The following may describe one smart logistics vehicle 110, but it is equally applicable to each of at least one smart logistics vehicle provided within the operation boundary 100.

[115] Referring to FIG. 7, the smart logistics vehicle 110 may move to the destination confirmation location set to correspond to the plurality of candidate destinations (e.g., CP1, CP2, CP3) along a pre-generated movement path. The smart logistics vehicle 110 may periodically transmit its own location to the control device 140 while moving along the movement path, and the map management unit 148 may determine whether the smart logistics vehicle 110 moves to the destination confirmation location existing in the form of a node on the movement path. When the smart logistics vehicle 110 moves to the destination confirmation location, the path selection unit 149 may control the smart logistics vehicle 110 to temporarily stop at the destination confirmation location, and contents to be described later may be performed during the temporary stop.

[116] Meanwhile, the plurality of smart logistics vehicles may move along the same movement path within the operation boundary 100, and the plurality of smart logistics vehicles arriving at the destination confirmation location may remain temporarily stopped on the movement path. Because of this, the plurality of smart logistics vehicles may occupy the destination confirmation location, resulting in a deadlock

with other smart logistics vehicles attempting to enter for arriving at the destination confirmation location thereafter.

[117] Accordingly, the path selection unit 149 may determine whether the destination confirmation location is accessible by determining the occupancy state of the smart logistics vehicle 110 at the destination confirmation location. When the destination confirmation location is accessible, the path selection unit 149 may enable the smart logistics vehicle 110 to travel along the movement path to enter the destination confirmation location. On the other hand, when the destination confirmation location is inaccessible, the path selection unit 149 may enable the smart logistics vehicle 110 to perform a circling mission in the vicinity, and when the destination confirmation location becomes accessible, may enable to stop the circling mission and to enter the destination confirmation location again. However, this is illustrative and is not necessarily limited thereto.

[118] When the smart logistics vehicle 110 is determined to enter the destination confirmation location, the path selection unit 149 may collect information about the plurality of candidate destinations (CP1, CP2, CP3). In this case, the path selection unit 149 may collect information about the plurality of candidate destinations (CP1, CP2, CP3) through the production device 120 or the inspection device 130 provided within the operation boundary 100, as shown in FIG. 6. The production

device 120 may provide the state information about the plurality of candidate destinations (CP1, CP2, CP3), and the inspection device 130 may provide the sensing information of sensors provided in the plurality of candidate destinations (CP1, CP2, CP3). However, this is illustrative and is not necessarily limited thereto.

[119] The path selection unit 149 may determine whether at least one of the plurality of candidate destinations (CP1, CP2, CP3) is accessible based on the information about the plurality of candidate destinations (CP1, CP2, CP3). For example, based on the information about the plurality of candidate destinations (CP1, CP2, CP3), when another smart logistics vehicle is arranged at at least one (e.g., CP1) of the plurality of candidate destinations (CP1, CP2, CP3) or when at least one (e.g., CP1) of the plurality of candidate destinations (CP1, CP2, CP3) changes to an inactive state, the corresponding candidate destination (CP1) may be determined to be inaccessible. However, this is illustrative and is not necessarily limited thereto.

[120] Also, when at least one candidate destination is determined to be inaccessible, the path selection unit 149 may set an accessible candidate destination among the plurality of candidate destinations (CP1, CP2, CP3) as a final destination.

[121] For example, there may exist a plurality of accessible candidate destinations excluding the inaccessible candidate

destinations among the plurality of candidate destinations (CP1, CP2, CP3), and in this case, the path selection unit 149 may determine information about accessible candidate destinations (e.g., CP2, CP3). The plurality of candidate destinations (CP1, CP2, CP3) may be destinations related to the mission of the smart logistics vehicle 110, and information about accessible candidate destinations (e.g., CP2, CP3) among the plurality of candidate destinations (CP1, CP2, CP3) related to the mission may be determined in order to perform the mission assigned to the smart logistics vehicle 110. In this case, the path selection unit 149 may determine the information about the accessible candidate destination (e.g., CP2, CP3) based on the information on the plurality of previously collected candidate destinations (CP1, CP2, CP3).

[122] Also, the path selection unit 149 may set any one (e.g., CP2) of the candidate destinations among the accessible candidate destinations (CP2, CP3) as the final destination based on the determined information.

[123] Thereafter, the path selection unit 149 may generate the movement path from the current location of the smart logistics vehicle 110 to the accessible candidate destination (e.g., CP2), and transmit the generated movement path to the smart logistics vehicle 110. Through this, the path selection unit 149 may enable the smart logistics vehicle 110 to move along

the generated movement path, and may control the smart logistics vehicle 110 to smoothly perform the assigned mission.

[124]

[125] Hereinafter, a smart logistics vehicle control method according to an exemplary embodiment of the present disclosure will be described with reference to FIG. 8 based on the configuration and operation of the control device 140 described above with reference to FIGS. 6 to 7.

[126] FIG. 8 is a view illustrating a smart logistics vehicle control method according to an exemplary embodiment of the present disclosure.

[127] Referring to FIG. 8, the map management unit 148 may set the destination confirmation location corresponding to the plurality of candidate destinations of the smart logistics vehicle 110 with respect to some sections within the operation boundary 100 (S801). Also, the map management unit 148 may transmit information about the set destination confirmation location to the path selection unit 149 (S802).

[128] The path selection unit 149 may receive information about the current location of the smart logistics vehicle 110 from the communication unit 114 of the smart logistics vehicle 110 (S803-1, S803-2). Also, the path selection unit 149 may set the current location of the smart logistics vehicle 110 as the departure point based on the received information, and may

generate the movement path moving from the departure point toward the destination confirmation location (S804).

[129] The path selection unit 149 may transmit the information about the generated movement path to the communication unit 114 of the smart logistics vehicle 110 (S805-1), the communication unit 114 may transmit the same to the control unit 115 (S805-2), and the control unit 115 may control the smart logistics vehicle 110 to move along the movement path.

[130] While the smart logistics vehicle 110 is moving, the smart logistics vehicle 110 may periodically provide the current location to the communication unit 146 (S806-1), and the communication unit 146 may provide the same to the map management unit 148 (S806-2). Based on this, the map management unit 148 may determine whether the smart logistics vehicle 110 enters the destination confirmation location provided on the movement path (S807). When the smart logistics vehicle 110 is determined to enter the destination confirmation location, the map management unit 148 may transmit the determination result to the path selection unit 149 (S808).

[131] Also, when the smart logistics vehicle 110 enters the destination confirmation location, the path selection unit 149 may receive the state information about the plurality of candidate destinations from the production device 120 (S809-1, S809-2) or receive the sensing information of the sensors

provided in the plurality of candidate destinations from the inspection device 130 (S810-1, S810-2).

[132] The path selection unit 149 may determine the accessible candidate destination by determining whether at least one of the plurality of candidate destinations is accessible based on the information transmitted through the production device 120 and the inspection device 130 (S811). The path selection unit 149 may set the accessible candidate destination as the final destination, and generate the movement path connecting the departure point and the destination by setting the current location of the smart logistics vehicle 110 as the departure point and setting the final destination as the destination (S812).

[133] Also, the path selection unit 149 may transmit the generated movement path to the communication unit 114 of the smart logistics vehicle 110 (S813-1), and the communication unit 114 may transmit the same to the control unit 115 (S813-2). The control unit 115 may control the smart logistics vehicle 110 to move to the accessible candidate destination based on the received movement path.

[134]

[135] As described above, when a predetermined destination becomes inaccessible due to a change in its situation, the smart logistics vehicle control method and the control device according to an exemplary embodiment of the present disclosure

can smoothly perform a mission previously assigned to a smart logistics vehicle by changing the destination to one accessible destination among other destinations capable of performing the same mission.

5 **[136]**

[137] Although shown and described with respect to a specific exemplary embodiment of the present disclosure, it will be apparent to those skilled in the art that the present disclosure can be modified and changed in various ways without departing from the technical idea of the present disclosure provided by the following claims.

10 **[138]** The present disclosure described above may be implemented as computer-readable code on a medium on which a program is recorded. The computer-readable medium may include all types of recording devices in which data readable by a computer system is stored. Examples of computer-readable medium may include hard disk drives (HDDs), solid state disks (SSDs), silicon disk drives (SDDs), ROMs, RAMs, CD-ROMs, magnetic tapes, floppy disks, optical data storage devices, and the like. Therefore, the above detailed description should not be construed as limiting in any respect and should be considered as illustrative. The scope of the present disclosure should be determined by a reasonable interpretation of the appended claims, and all changes within the equivalent scope of the

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present disclosure may be included in the scope of the present disclosure.

[139]

[140] Description of Reference Numerals

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[141] 100 : smart factory

[142] 110 : smart logistics vehicle

[143] 120 : production device

[144] 130 : inspection device

[145] 140 : control device

CLAIMS

[Claim 1] A smart logistics vehicle control method, the method comprising:

5 controlling at least one smart logistics vehicle to move toward a destination confirmation location corresponding to a plurality of candidate destinations related to a currently assigned mission;

10 determining whether at least one of the plurality of candidate destinations is accessible in response that entering the destination confirmation location while the at least one smart logistics vehicle is moving; and

 setting an accessible candidate destination among the plurality of candidate destinations as a final destination.

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[Claim 2] The method of claim 1, wherein the controlling comprises:

 collecting information about a current location of the at least one smart logistics vehicle;

20 generating a movement path from a departure point corresponding to the current location to the destination confirmation location based on the collected information; and

 controlling the at least one smart logistics vehicle to move toward the destination confirmation location based on the generated movement path.

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[Claim 3] The method of claim 1, wherein the destination confirmation location is predetermined to correspond to at least one of a node, a zone, and a lane existing on a path along which the at least one smart logistics vehicle moves.

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

determining whether the destination confirmation location is accessible while the at least one smart logistics vehicle is moving; and

determining whether at least one of the plurality of candidate destinations is accessible by allowing the at least one smart logistics vehicle to enter the destination confirmation location in response that the destination confirmation location is accessible.

[Claim 5] The method of claim 4, wherein the determining whether at least one is accessible comprises:

controlling the at least one smart logistics vehicle to perform a circling mission in response that the destination confirmation location is inaccessible; and

determining whether the at least one of the plurality of candidate destinations is accessible by allowing the at least one smart logistics vehicle to stop the circling mission and to enter

the destination confirmation location in response that the destination confirmation location becomes accessible while the at least one smart logistics vehicle is performing the circling mission.

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[Claim 6] The method of claim 1, wherein the determining comprises:

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collecting information about the plurality of candidate destinations in response that entering the destination confirmation location; and

determining whether at least one of the plurality of candidate destinations is accessible based on the collected information.

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[Claim 7] The method of claim 6, wherein the collecting comprises:

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collecting the information about the plurality of candidate destinations through a sensor provided at each of the plurality of candidate destinations in response that entering the destination confirmation location.

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

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determining that a corresponding candidate destination is inaccessible, in response that another smart logistics vehicle

is located at at least one of the plurality of candidate destinations, or in response that at least one of the plurality of candidate destinations changes to an inactive state.

5 [Claim 9] The method of claim 1, wherein the setting comprises:

 setting one of the accessible candidate destinations as the final destination in response that the plurality of accessible candidate destinations exists.

10 [Claim 10] The method of claim 1, further comprising:
 after the setting,

 generating a movement path from a current location of the at least one smart logistics vehicle to the final destination;
15 and

 controlling the at least one smart logistics vehicle to move along the generated movement path.

 [Claim 11] A control device, the device comprising:

20 a communication unit configured to communicate with at least one smart logistics vehicle; and

 a path selection unit configured to control the at least one smart logistics vehicle to move toward a destination confirmation location corresponding to a plurality of candidate destinations related to a currently assigned mission, for
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determining whether at least one of the plurality of candidate destinations is accessible in response that entering the destination confirmation location while the at least one smart logistics vehicle is moving, and for setting an accessible candidate destination among the plurality of candidate destinations as a final destination.

[Claim 12] The device of claim 11, wherein the path selection unit further configured to:

collect information about a current location of the at least one smart logistics vehicle,

generate a movement path from a departure point corresponding to the current location to the destination confirmation location based on the collected information, and

control the at least one smart logistics vehicle to move toward the destination confirmation location based on the generated movement path.

[Claim 13] The device of claim 11, wherein the path selection unit further configured to:

determine whether the destination confirmation location is accessible while the at least one smart logistics vehicle is moving and

determine whether at least one of the plurality of candidate destinations is accessible by allowing the at least one smart

logistics vehicle to enter the destination confirmation location in response that the destination confirmation location is accessible.

5 [Claim 14] The device of claim 13, wherein the path selection unit further configured to:

 control the at least one smart logistics vehicle to perform a circling mission in response that the destination confirmation location is inaccessible and

10 determine whether the at least one of the plurality of candidate destinations is accessible by allowing the at least one smart logistics vehicle to stop the circling mission and to enter the destination confirmation location in response that the destination confirmation location becomes accessible while the
15 at least one smart logistics vehicle is performing the circling mission.

 [Claim 15] The device of claim 11, wherein the path selection unit further configured to:

20 collect information about the plurality of candidate destinations in response that the at least one smart logistics vehicle enters the destination confirmation location and

 determine whether at least one of the plurality of candidate destinations is accessible based on the collected information.

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[Claim 16] The device of claim 15, wherein the path selection unit further configured to:

collect the information about the plurality of candidate destinations through a sensor provided at each of the plurality of candidate destinations in response that the at least one smart logistics vehicle enters the destination confirmation location.

[Claim 17] The device of claim 11, wherein the path selection unit further configured to determine that a corresponding candidate destination is inaccessible, in response that another smart logistics vehicle is located at at least one of the plurality of candidate destinations, or in response that at least one of the plurality of candidate destinations changes to an inactive state.

[Claim 18] The device of claim 11, wherein the path selection unit further configured to set one of the accessible candidate destinations as the final destination in response that the plurality of accessible candidate destinations exists.

[Claim 19] The device of claim 11, wherein the path selection unit further configured to:

generate a movement path from a current location of the at least one smart logistics vehicle to the final destination in response that the final destination is set and

control the at least one smart logistics vehicle to move along the generated movement path.