

DESCRIPTION

Invention Title: METHOD AND DEVICE FOR VIRTUALLY CONTROLLING LOGISTICS ROBOT

Technical Field

- [1] The present invention relates to a method and a device for virtually controlling a logistics robot for effectively detecting the surroundings of a logistics robot moving within an operation boundary and controlling the logistics robot based on a detection result.

Background Art

- [2] In general logistics warehouses or factories, as well as in smart factories that manufacture products of different specifications using various components, logistics robots are being introduced for flexible and efficient supply and transport of components and the like.
- [3] A logistics robot is a concept collectively referring to an autonomous mobile robot (AMR: Autonomous Mobile Robot) and an automated guided vehicle (AGV: Automated Guided Vehicle), and such a logistics robot may perform movement and work according to control of a control device.
- [4] In a smart factory, a logistics robot may move along an optimal movement path based on path planning to perform a mission assigned from a control device.
- [5] Meanwhile, in a process where a plurality of logistics robots move according to their respective movement paths, collisions between each other may occur, and in addition to collisions between logistics robots, cases such as a logistics robot colliding with surrounding facilities may also occur. When a collision occurs with a logistics robot, not only damage

occurs due to the logistics robot being damaged, but also significant damage may be caused to the entire process due to process delays and the like.

[6] In addition, even if a collision does not occur, situations may occur where the movement of a logistics robot is interfered with due to surrounding objects and the like, and in this case as well, damage such as process delays may be caused.

[7] In order to prevent such damage, there is a need to propose a method that enables preventing operation interference in advance by controlling the operation of a logistics robot through peripheral detection of the logistics robot.

[8]

[9] The matters described as the background art above are only for enhancing understanding of the background of the present invention, and should not be taken as an admission that they correspond to prior art already known to a person having ordinary skill in this technical field.

Disclosure

Technical Problem

[10] An object of the present invention is to provide a method and a device for virtually controlling a logistics robot that detects the surroundings of a logistics robot based on a virtual area and controls the movement of the logistics robot according to a detection result so that a process may be efficiently operated.

[11]

[12] The problem of the present invention is not limited to the problem mentioned above, and other problems not mentioned will be clearly understood by a person skilled in the art from the description below.

[13]

Technical Solution

- [14] A method for virtually controlling a logistics robot according to an embodiment of the present invention for realizing the above problem includes: collecting logistics robot information for a logistics robot and load information for at least one load loaded on the logistics robot; setting a first virtual area corresponding to an actual occupied space of the logistics robot based on the logistics robot information and the load information; determining whether an operation control condition of the logistics robot is satisfied based on a positional relationship between the first virtual area and a second virtual area set to correspond to an actual occupied space of another object other than the logistics robot on which the first virtual area is set; and outputting a control signal for operation control of the logistics robot when the operation control condition is satisfied.
- [15] For example, the first virtual area may be set to be at least partially expanded compared to the actual occupied space of the logistics robot.
- [16] For example, the first virtual area is a virtual area on a plane corresponding to the actual occupied space of the logistics robot, and the operation control condition may include a first operation control condition determined based on a positional relationship between the first virtual area and the second virtual area, and a second operation control condition determined based on three-dimensional shapes of the logistics robot on which the first virtual area is set and the another object on which the second virtual area is set when the first operation control condition is satisfied.

- [17] For example, the three-dimensional shape of the logistics robot may include a three-dimensional shape of a load loaded on the logistics robot.
- [18] For example, the three-dimensional shape of the load may be included in the load information.
- [19] For example, whether the operation control condition is satisfied may be determined regardless of whether a communication connection between the logistics robot and the another object is established.
- [20] For example, the virtual area may be set in consideration of at least one of a type, a speed, a loading state, position information, and path information of the logistics robot included in the logistics robot information.
- [21] For example, whether the operation control condition is satisfied may be determined based on at least one of a degree of overlap and a degree of proximity according to the positional relationship between the first virtual area and the second virtual area.
- [22] For example, the control signal may cause at least one of a speed and a movement direction of the logistics robot to be adjusted.
- [23] For example, the outputting the control signal may include outputting the control signal further in consideration of a preset priority between the logistics robot and the another object.
- [24]
- [25] A device for virtually controlling a logistics robot according to an embodiment of the present invention for realizing the above problem includes: a collection unit configured to collect logistics robot information for a logistics robot and load information for at least one load loaded on the logistics robot; a setting unit configured to

set a first virtual area corresponding to an actual occupied space of the logistics robot based on the logistics robot information and the load information; a determination unit configured to determine whether an operation control condition of the logistics robot is satisfied based on a positional relationship between the first virtual area and a second virtual area set to correspond to an actual occupied space of another object other than the logistics robot on which the first virtual area is set; and an output unit configured to output a control signal for operation control of the logistics robot when the operation control condition is satisfied.

- [26] For example, the first virtual area may be set to be at least partially expanded compared to the actual occupied space of the logistics robot.
- [27] For example, the first virtual area is a virtual area on a plane corresponding to the actual occupied space of the logistics robot, and the operation control condition may include a first operation control condition determined based on a positional relationship between the first virtual area and the second virtual area, and a second operation control condition determined based on three-dimensional shapes of the logistics robot on which the first virtual area is set and the another object on which the second virtual area is set when the first operation control condition is satisfied.
- [28] For example, the three-dimensional shape of the logistics robot may include a three-dimensional shape of a load loaded on the logistics robot.
- [29] For example, the three-dimensional shape of the load may be included in the load information.
- [30] For example, whether the operation control condition is satisfied may be determined regardless of whether a

communication connection between the logistics robot and the another object is established.

- [31] For example, the virtual area may be set in consideration of at least one of a type, a speed, a loading state, position information, and path information of the logistics robot included in the logistics robot information.
- [32] For example, whether the operation control condition is satisfied may be determined based on at least one of a degree of overlap and a degree of proximity according to the positional relationship between the first virtual area and the second virtual area.
- [33] For example, the control signal may cause at least one of a speed and a movement direction of the logistics robot to be adjusted.
- [34] For example, the output unit may output the control signal further in consideration of a preset priority between the logistics robot and the another object.

Advantageous Effects

- [35] According to the various embodiments of the present invention as described above, peripheral detection performance for a logistics robot may be improved by utilizing a virtual area.
- [36] In addition, by controlling the operation of a logistics robot based on the result of such peripheral detection, operation interference with the logistics robot may be prevented, and accordingly, process delays may be prevented.
- [37]
- [38] The effects obtainable from the present invention are not limited to the effects mentioned above, and other effects not mentioned will be clearly understood by a person having ordinary skill in the technical field to which the present invention belongs from the description below.

Description of Drawings

- [39] FIG. 1 is a block diagram illustrating an example of an operation boundary configuration applicable to embodiments of the present invention.
- [40] FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to embodiments of the present invention.
- [41] FIG. 3 is a block diagram illustrating an example of a logistics robot configuration applicable to embodiments of the present invention.
- [42] FIG. 4 is a sequence diagram for explaining a virtual control process according to an embodiment of the present invention.
- [43] FIG. 5 is a diagram illustrating an example of determining whether a first operation control condition is satisfied applicable to embodiments of the present invention.
- [44] FIG. 6 is a diagram illustrating an example of determining whether a second operation control condition is satisfied applicable to embodiments of the present invention.

Mode for Disclosure

- [45] The specific structural or functional descriptions of the embodiments of the present invention disclosed in the present specification or application are merely illustrated for the purpose of describing the embodiments according to the present invention, and the embodiments according to the present invention may be implemented in various forms and should not be construed as being limited to the embodiments described in the present specification or application.
- [46] The embodiments according to the present invention may have various modifications and may have various forms, and thus specific embodiments are illustrated in the drawings and described in detail in the present specification or application. However, this is not intended to limit the

embodiments according to the concept of the present invention to specific disclosed forms, and should be understood to include all modifications, equivalents, or substitutes included in the spirit and technical scope of the present invention.

- [47] Unless otherwise defined, all terms used herein, including technical or scientific terms, have the same meaning as commonly understood by a person having ordinary skill in the technical field to which the present invention belongs. Terms such as those defined in commonly used dictionaries should be interpreted as having meanings consistent with the meanings in the context of the related technology, and are not interpreted in an ideal or overly formal sense unless explicitly defined in the present specification.
- [48] Hereinafter, embodiments disclosed in the present specification will be described in detail with reference to the accompanying drawings, wherein the same or similar components are assigned the same reference numerals regardless of drawing reference numerals, and redundant descriptions thereof will be omitted.
- [49] The suffixes "module" and "unit" for components used in the following description are assigned or used interchangeably only in consideration of ease of writing the specification, and do not have meanings or roles that are distinguished from each other by themselves.
- [50] In describing the embodiments disclosed in the present specification, if it is determined that detailed descriptions of related known technologies may obscure the gist of the embodiments disclosed in the present specification, the detailed descriptions thereof will be omitted. In addition, the accompanying drawings are only for easy understanding of the embodiments disclosed in the present specification, and the technical ideas disclosed in the present specification are not limited by the accompanying drawings, and should be

understood to include all modifications, equivalents, or substitutes included in the spirit and technical scope of the present invention.

- [51] Terms including ordinal numbers such as first and second may be used to describe various components, but the components are not limited by the terms. The terms are used only for the purpose of distinguishing one component from another component.
- [52] When it is mentioned that a certain component is "connected" or "coupled" to another component, it should be understood that the component may be directly connected or coupled to the other component, but other components may exist in between. On the other hand, when it is mentioned that a certain component is "directly connected" or "directly coupled" to another component, it should be understood that no other component exists in between.
- [53] Singular expressions include plural expressions unless the context clearly indicates otherwise.
- [54] In the present specification, terms such as "comprises" or "has" should be understood to designate that features, numbers, steps, operations, components, parts, or combinations thereof described in the specification exist, and do not preclude the possibility of existence or addition of one or more other features, numbers, steps, operations, components, parts, or combinations thereof.
- [55] A controller may include a communication device that communicates with other controllers or sensors for control of a function in charge, a memory that stores an operating system, logic instructions, and input/output information, and one or more processors that perform judgment, computation, determination, and the like necessary for control of the function in charge.

[56]

- [57] First, a configuration of an operation boundary in which a logistics robot according to an embodiment is disposed and operated will be described with reference to FIG. 1.
- [58] Referring to FIG. 1, an operation boundary 100 may include a logistics robot 110, a facility 120, a monitoring device 130, and a control device 140.
- [59] A plurality of logistics robots 110, a plurality of facilities 120, and a plurality of sensing devices 130 may be provided in the operation boundary 100 according to a production process of a product and a target production speed. The operation boundary 100 is a smart factory, and the plurality of facilities may be implemented as production devices, but are not necessarily limited thereto. Hereinafter, each component will be described.
- [60] First, the logistics robot 110 may include an autonomous mobile robot (Autonomous Mobile Robot, hereinafter referred to as 'AMR' for convenience) and an automated guided vehicle (Automated Guided Vehicle, hereinafter referred to as 'AGV' for convenience). According to an operation policy of the logistics robot 110 in the operation boundary 100, only one type of AGV or AMR may be operated, or AGV and AMR may be operated together within the operation boundary 100.
- [61] The AGV generally performs operations (movement, direction change, stop, etc.) required within the operation boundary 100 by recognizing and following guidance equipment disposed on the floor for guidance of the AGV. Here, the guidance equipment may mean optically recognizable markers (spots, 2D codes, etc.), tags recognizable in a non-contact manner at close range (e.g., NFC tags, RFID tags, etc.), magnetic strips, wires, etc., but this is illustrative and is not necessarily limited thereto. The guidance equipment may be disposed continuously on the floor or may be disposed discontinuously and spaced apart from each other. Since the AGV basically performs operations through recognition and following of the

guidance equipment, the guidance equipment is required to be installed in advance before operation, and when the AGV needs to be moved to a new path or the existing path needs to be modified, the new installation or modification of the guidance equipment needs to be physically performed. In addition, since the AGV does not deviate from the path set through the guidance equipment, when an obstacle is detected on or around the path, it is general to stop until the detected obstacle disappears or separate control is received. In operation of the AGV, since the control device 140 must control the AGV based on the guidance equipment, it may transmit commands having meanings such as 'drive until the 3rd marker is recognized from the current position', 'change heading direction by 90 degrees when the 3rd marker is recognized', etc. to the AGV in individual command units or in mission (e.g., recovery, supply, charging, patrol, etc.) units including a plurality of commands.

- [62] The AMR may determine a current position (i.e., localization) through peripheral sensing, and the most distinguishing point from the AGV is that the AMR is capable of self-path planning using localization and a map. Therefore, when a map with compatible coordinates is shared between the AMR and the control device 140, the control device 140 may control the AMR in a manner of instructing a path to the AMR based on coordinates. In addition, when an obstacle is detected during driving, the AMR may set an avoidance path by itself to avoid the obstacle and then return to the original path. The function of the control device 140 setting the path of the AMR as one or more waypoint coordinates may be referred to as global path planning, and the function of the AMR setting a movement path or an avoidance path between waypoint coordinates according to global path planning may be referred to as local path planning.

[63]

- [64] Next, the facility 120 may mean, for example, a device (robot arm, conveyor belt, etc.) that performs a production process of a product within the operation boundary 100, and in a broader sense, may also mean a device disposed to assist mission performance such as entry and exit of the logistics robot 110 when the production process is performed by a person. The device disposed to assist mission performance may be a device for sensing a state of a designated position where a pallet transported by the logistics robot 110 may be unloaded or collected within an area where a specific production process is performed, a device for determining a process progress, an entry blocking means within the area, etc., but is not necessarily limited thereto.
- [65] For example, the facility 120 is controlled through a PLC (Programmable Logic Controller), and may perform communication with the control device 140 in relation to process progress.
- [66] The monitoring device 130 may perform a function of acquiring information for determining a situation within the operation boundary 100 and transmitting the information to the control device 140. For example, the monitoring device 130 may include a camera, a proximity sensor, etc., but is not necessarily limited thereto.
- [67] The control device 140 may perform communication with the above-described components 110, 120, and 130 to acquire information necessary for operation of the operation boundary 100 or control each component. For example, the control device 140 may perform dispatching of the logistics robot 110, path setting, mission assignment, process management by product, material management, etc.
- [68] In implementation, the control device 140 may include a local control device (ACS: AMR/AGV Control System) that controls surrounding process facilities based on the position of the AGV/AMR and performs mission-based control of the AGV/AMR,

and an integrated control device (MoRIMS: Mobile Robot Integrated Monitoring System) that integrates and controls two or more local control devices. The integrated control device may perform status, path, logistics flow setting, and traffic control of all logistics robots 110 within the operation boundary 100 from each of the plurality of local control devices. For example, when the local control device (ACS) is provided for each logistics robot unit of the same manufacturer or same model, the integrated control device may perform integrated control for collision prevention such as bottleneck level analysis of intersection/overlap areas, driving acceleration/deceleration control, and avoidance path regeneration through heterogeneous traffic distribution control based on information acquired through a plurality of local control devices (ACS).

[69] In addition, the integrated control device may also have a manufacturing execution system (MES: Manufacturing Execution System) as its upper control entity, and the manufacturing execution system (MES) may be linked with an automated scheduler (APS: Advanced Planning & Scheduling).

[70] In addition to the configuration 110, 120, 130, and 140 of the above-described operation boundary 100, devices for mutual communication between each component such as beacons, repeaters, and APs (Access Points), chargers for charging the logistics robot 110, loading spaces for component storage or loading, spaces where finished products or intermediate products are stored, traffic lights, barriers, waiting spaces for idle logistics robots 110, etc. may be appropriately disposed within the operation boundary 100 as a matter of course.

[71] Hereinafter, a configuration of the control device 140 applicable to embodiments of the present invention will be described with reference to FIG. 3.

[72]

- [73] FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to embodiments of the present invention. Each component illustrated in FIG. 2 mainly shows components related to embodiments of the present invention, and in actual implementation of the control device 140, more or fewer components may be included.
- [74] Referring to FIG. 3, 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 monitoring unit 147, a map management unit 148, and a work schedule management unit 149.
- [75] The firmware management unit 141 may acquire the latest firmware of the logistics robot 110 through the communication unit 146, transmit it to the logistics robot 110 so that firmware update is performed, and maintain the firmware of the logistics robot 110 in the latest state.
- [76] The traffic control unit 142 controls traffic lights and barriers based on the path of the logistics robot 110, and may also recalculate the path of the logistics robot 110 according to traffic.
- [77] The process management unit 143 may define a process for each product and manage missions such as process progress and progress location.
- [78] The production/logistics management unit 144 may dispatch the logistics robot 110 based on missions.
- [79] The inventory management unit 145 manages the position and quantity of each material, and such information may be useful for more efficient process operation, such as dispatching the logistics robot 110 to a destination before the time when actual assembly/consumption of materials is detected for pallet pickup or recovery.

- [80] The communication unit 146 may perform communication with internal components of the operation boundary 100 such as the logistics robot 110, facility 120, and monitoring device 130, as well as external entities such as a firmware update server.
- [81] The monitoring unit 147 may monitor the position, path, battery state, communication state, power train state, etc. of each individual logistics robot 110. Here, the path is 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 Charge), state of health (SOH: State Of Health), etc. The communication state may include information about currently activated communication protocols (Wi-Fi, etc.), connected APs, distance to APs, channels in use, etc. In addition, the power train state may include load, temperature, RPM, etc. of the drive system.
- [82] In addition, the vehicle monitoring unit 147 may also check currently assigned missions, operation modes, firmware versions, etc. for each individual logistics robot 110.
- [83] The map management unit 148 acquires map data in the form of a grid map acquired while the AMR among the logistics robots 110 drives inside the operation boundary 100, and may provide a tool for the factory manager to edit the acquired map data. Through editing of map data, zones where the logistics robot 110 performs one or more preset operations upon entry, virtual lanes, intersections, entry prohibition areas, etc. may be set, but this is illustrative and is not necessarily limited thereto. In addition, the map management unit 148 may also distribute the corresponding map through the communication unit 146 to remaining logistics robots 110 other than the logistics robot 110 that acquired the initial grid map through actual driving.

- [84] The work schedule management unit 149 may manage and monitor the missions of the logistics robot 110 based on the process information of the operation boundary 100 received through the communication unit 146 from the facility 120 and the monitoring device 130. In addition, the work schedule management unit 149 selects a specific logistics robot 110 and assigns a mission thereto, and may set the global path of the logistics robot 110 according to the assigned mission.
- [85] Next, the logistics robot will be described with reference to FIG. 3.
- [86]
- [87] FIG. 3 is a block diagram illustrating an example of a logistics robot configuration applicable to embodiments of the present invention.
- [88] Referring to FIG. 3, the logistics robot 110 may include a driving unit 111, a sensing unit 112, a loading unit 113, a communication unit 114, and a control unit 115. Hereinafter, each component will be described.
- [89] The driving unit 111 may include a driving source, wheels, and suspension, etc. involved in movement, steering, and stopping of the logistics robot 110. As the driving source, an electric motor that receives power from a built-in battery (not shown) may be used. The wheels may include one or more driving wheels that receive driving force from the driving source and non-driving wheels that rotate by movement of the vehicle body without receiving driving force. Depending on implementation, when a plurality of driving wheels are provided, a driving source may be matched to each driving wheel so that rotation of each driving wheel may be independently controlled. In such a case, steering may be achieved by rotating the vehicle body without a separate steering means by making rotation directions of different driving wheels different from each other. 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.

- [90] The sensing unit 112 is for sensing the surrounding environment of the logistics robot 110 or its own operation state, 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.
- [91] The encoder may output information that may determine how much the wheel has rotated using light emitted from a light emitting element (e.g., photodiode). For example, the encoder may count the number of slits disposed along the circumferential direction on the wheel or a disk rotating together with the wheel during a unit time. The control unit 115 may perform odometry that estimates displacement by analyzing the amount of position change over time with data acquired through the encoder and the gyro sensor. However, there may be an error between the displacement estimated based on the encoder data and the actual displacement due to slip or wear of the wheel (change in wheel effective radius). Therefore, when performing odometry, the control unit 115 may output a result having a tendency close to the actual value by performing correction for noise and error using a predetermined algorithm (e.g., EKF: Extended Kalman Filter) on information collected from the wheel and the gyro sensor. Such odometry may be particularly useful when current position determination (Localization) using the 2D laser scanner to be described later is impossible.
- [92] The 2D laser scanner may scan the surrounding environment by irradiating a laser to the surroundings through a rotating reflector and sensing a signal reflected back. At this time, detection results in the form of a point cloud may be output

by analyzing the intensity of the reflected signal and the time difference between irradiation and reception.

- [93] The 3D vision camera may calculate the distance to an object based on the parallax between two cameras spaced apart by a certain distance, that is, the pixel distance between images captured through each camera. At this time, a texture projector that projects infrared light of a predetermined pattern may be provided so that detection is possible even for a flat object of the same color (e.g., a white wall), etc.
- [94] In general, the 2D laser scanner is used for mapping, navigation, object recognition, etc., and the 3D camera may be utilized for obstacle avoidance especially during navigation, but this is illustrative and is not necessarily limited thereto.
- [95] The loading unit 113 is a means for loading objects to be transported, and may be a top plate itself on the upper part of the vehicle body or a table, lift, turntable rotating along a vertical axis, fork lift, conveyor disposed on the top plate, or a combination thereof. In the case of a fork lift, similar to a forklift truck, telescopic and tilting functions may be supported.
- [96] The communication unit 114 may perform communication with other components within the operation boundary 100 such as the facility 120 and the control device 140, may support communication between logistics robots 110, and may also communicate with a charger when performing a charging mission.
- [97] The control unit 115 is an entity that performs overall control of each of the above-described components 111, 112, 113, and 114, and may perform current mission, current position, destination determination, path planning, loading unit control, etc. based on information acquired from the control device 140 through the communication unit 114.

[98] Hereinafter, a process in which the operation of a logistics robot is controlled through a virtual control device according to an embodiment of the present invention will be described in detail with reference to FIG. 4.

[99]

[100] FIG. 4 is a sequence diagram for explaining a virtual control process according to an embodiment of the present invention. FIG. 4 mainly shows components related to the description of an embodiment of the present invention, and the actual virtual control device or virtual control method may be implemented including more or fewer components as a matter of course.

[101] First, the virtual control according to an embodiment of the present invention may be performed by a virtual control device 150 including a collection unit 151, a setting unit 152, a determination unit 153, and an output unit 154. The virtual control device 150 may be provided within the operation boundary 100, but may also be provided outside the operation boundary 100. Hereinafter, the virtual control process performed through each configuration will be described in detail.

[102] The collection unit 151 receives and collects logistics robot information for the logistics robot 110 and load information for at least one load loaded on the logistics robot, and may further receive and collect facility information in step S402.

[103] The logistics robot information, load information, and facility information may be acquired from the above-described control device 140, and in this case, the control device 140 may receive the logistics robot information from the logistics robot 110 and transmit the received logistics robot information to the collection unit 151 again in step S401. And, the load information and facility information may be

stored in the production/logistics management unit 144 of the control device 140 and then provided to the collection unit 151.

[104] In addition, the collection unit 151 may also receive monitoring information from the monitoring device 130 in step S403. The monitoring information may include an operation state of the facility 120 within the operation boundary 100 sensed through a camera, a proximity sensor, etc. in step S403.

[105] The setting unit 152 may receive the information collected from the collection unit 151 in step S404, and may set a first virtual area corresponding to an actual occupied space of the logistics robot 110 based on the logistics robot information and the load information. In addition, the setting unit 152 may also set a second virtual area set to correspond to an actual occupied space of another object other than the logistics robot on which the first virtual area is set in step S405.

[106] Here, another object other than the logistics robot 110 on which the first virtual area is set may include another logistics robot 110, facility 120, etc., and for example, when the another object is a logistics robot 110, the second virtual area may be set based on the logistics robot information and load information in the same way as the first virtual area, and when the another object is a facility 120, the second virtual area may be set based on the facility information and monitoring information, but is not necessarily limited thereto, and the second virtual area may also be set in other ways.

[107] Meanwhile, the first virtual area may be set to be at least partially expanded compared to the actual occupied space of the logistics robot 110, and may be set in consideration of at least one of a type, a speed, and a loading state of the logistics robot 110 included in the

logistics robot information. Meanwhile, the logistics robot information may further include position information and path information of the logistics robot.

[108] For example, different first virtual areas may be set according to the type of the logistics robot 110, and the degree to which the first virtual area is expanded compared to the actual occupied space may be determined in proportion to the speed or acceleration of the logistics robot 110, or may be determined differently according to the loading state of the logistics robot 110.

[109] The first virtual area and the second virtual area set in this way are transmitted to the determination unit 153 in step S406, and the determination unit 153 may determine whether an operation control condition of the logistics robot 110 is satisfied based on the positional relationship between each virtual area in step S407.

[110] More specifically, the operation control condition of the logistics robot 110 may include a first operation control condition and a second operation control condition, and may be satisfied when both the first operation control condition and the second operation control condition are satisfied.

[111] Here, the first operation control condition may be determined based on the positional relationship between the first virtual area and the second virtual area, and in this case, the first virtual area and the second virtual area may be implemented as planes. And, the second operation control condition may be determined based on three-dimensional shapes of the logistics robot 110 on which the first virtual area is set and another object on which the second virtual area is set, and may be determined when the first operation control condition is satisfied.

- [112] More specific details related to determination of whether the operation control condition is satisfied will be described below with reference to FIGS. 5 and 6.
- [113]
- [114] First, FIG. 5 is a diagram illustrating an example of determining whether a first operation control condition is satisfied applicable to embodiments of the present invention.
- [115] FIG. 5 shows a view looking from above at a plurality of logistics robots 110-1 and 110-2 and virtual areas V-1 and V-2 for them.
- [116] Referring to FIG. 5, a peripheral detection situation of one logistics robot 110-1 with respect to another logistics robot 110-2 is shown. In this case, the first virtual area V-1 is set for the logistics robot 110-1, and the second virtual area V-2 may be set for the logistics robot 110-2, which is another object other than the logistics robot 110-1 on which the first virtual area V-1 is set.
- [117] In this case, the first virtual area V-1 and the second virtual area V-2 may be implemented as planes at least partially expanded compared to the actual occupied spaces of each logistics robot 110-1 and 110-2.
- [118] The determination unit 153 may determine whether the first collision condition is satisfied based on the positional relationship between the virtual areas V-1 and V-2 as described above. For example, the determination unit 153 may determine whether the first operation control condition is satisfied based on the degree of overlap between the first virtual area V-1 for one logistics robot 110-1 and the second virtual area V-2 for another logistics robot 110-2 as shown in FIG. 5.
- [119] More specifically, the determination unit 153 may determine that the first operation control condition is

satisfied when the degree of overlap exceeds a preset value, and in this case, the degree of overlap may be defined as a proportion that the second virtual area V-2 for another logistics robot 110-2 occupies in the area of the first virtual area V-1 for one logistics robot 110-1.

[120] However, unlike this, the determination unit 153 may also determine that the first operation control condition is satisfied when the virtual area V-1 for one logistics robot 110-1 and the virtual area V-2 for another logistics robot 110-2 approach within a certain distance even if they do not overlap. That is, the first operation control condition may also be determined based on the degree of proximity between the first virtual area V-1 and the second virtual area V-2.

[121] As a result of the above determination, when the first operation control condition is satisfied, whether the second operation control condition is satisfied may be determined, and this will be described with reference to FIG. 6.

[122]

[123] FIG. 6 is a diagram illustrating an example of determining whether a second operation control condition is satisfied applicable to embodiments of the present invention.

[124] FIG. 6 shows a view looking from the side at the plurality of logistics robots 110-1 and 110-2 and virtual areas V-1 and V-2 for them shown in FIG. 5.

[125] Referring to FIG. 6, when the first operation control condition is satisfied, the determination unit 153 determines whether the second operation control condition is satisfied, and the second operation control condition may be determined in consideration of the three-dimensional shapes of the logistics robot 110-1 on which the first virtual area V-1 is set and another logistics robot 110-2 on which the second virtual area V-2 is set.

- [126] In this case, the three-dimensional shape may include a three-dimensional shape of a load loaded on the logistics robot 110-1 on which the first virtual area V-1 is set. In addition, if there is also a loaded load on the logistics robot 110-2 on which the second virtual area V-2 is set, the three-dimensional shape of the load may be reflected in its three-dimensional shape.
- [127] In this case, the three-dimensional shape of the load may be included in the collected load information, and the load information may include, for example, information about the shape such as height, width, and length of the load, and information such as center of gravity.
- [128] Meanwhile, the first virtual area V-1 implemented as a plane may be set to be expanded compared to the actual occupied area of the logistics robot 110-1, and in this case, there may be cases where there is actually no risk of collision occurrence even when the virtual areas V-1 and V-2 are close to each other or overlap.
- [129] In particular, since the shapes of the load L are diverse, and cases where the load L has an irregular shape may also be assumed, by additionally determining the second operation control condition, the necessity of controlling the operation (especially, movement) of the logistics robot 110-1 due to another object may be determined more precisely.
- [130] That is, by performing a two-dimensional evaluation of the necessity of operation control through determination of whether the first operation control condition is satisfied, and additionally performing a three-dimensional evaluation of the necessity of operation control through determination of whether the second operation control condition is satisfied, when the risk that another object such as another logistics robot 110-2 interferes with the operation of the logistics robot 110-1 to be controlled is substantially low, process disruption due to controlling the operation of the logistics

robot 110-1 to be controlled may be prevented. That is, in this case, additional operation control may not be performed so that the logistics robot 110-1 to be controlled operates according to the original control target.

[131]

[132] Meanwhile, returning to FIG. 4 again, the determination unit 153 may determine whether the first operation control condition and the second operation control condition are satisfied regardless of whether a communication connection between a plurality of logistics robots 110 is established. According to the virtual control according to an embodiment of the present invention, since operation control is performed based on the logistics robot information and load information for the logistics robot 110 regardless of whether a communication connection between the logistics robot 110 and another object is established, the surroundings of the logistics robot 110 to be controlled may be detected and the operation of the logistics robot 110 may be controlled according to the result even when communication between the logistics robot 110 to be controlled and another object is impossible.

[133] In particular, even when the another object is another logistics robot 110 other than the logistics robot 110 on which the first virtual area is set, and mutual communication is impossible due to the two logistics robots 110 being of different types, etc., it becomes possible to predict whether a collision between logistics robots 110 will occur.

[134] Thereafter, the determination unit 153 transmits the determination result of whether the operation control condition is satisfied to the output unit 154 in step S408, so that the output unit 154 may output a control signal corresponding to the determination result of whether the operation control condition is satisfied in step S409.

[135] In this case, the control signal may cause at least one of a speed and a movement direction of the logistics robot 110 to be adjusted, and may also be output based on a priority between the logistics robot 110 and another object.

[136] For example, when the another object is another logistics robot 110, the control signal may be output based on a priority between the logistics robot 110 on which the first virtual area is set and another logistics robot 110, and when the priority of another logistics robot 110 is higher, a control signal may be output such that the logistics robot 110 on which the first virtual area is set moves in a direction different from the existing direction of travel, stops, etc. so as not to interfere with the operation of another logistics robot 110.

[137] Meanwhile, the output control signal may be transmitted to the control device 140 and transmitted to the logistics robot 110 in step S409, and the control device 140 receiving the control signal may control the operation of the logistics robot 110 according to the control signal in step S410. Alternatively, the control signal may be directly transmitted to the logistics robot 110 and the operation of the logistics robot 110 may be controlled accordingly.

[138]

[139] By the various embodiments of the present invention as described above, peripheral detection performance for a logistics robot may be improved by utilizing a virtual area.

[140] In addition, by controlling the operation of a logistics robot based on the result of such peripheral detection, operation interference with the logistics robot may be prevented, and accordingly, process delays may be prevented.

[141]

[142] Although the present invention has been illustrated and described in relation to specific embodiments of the present invention as described above, it will be apparent to a person having ordinary skill in the art that the present invention may be variously improved and changed without departing from the technical spirit of the present invention provided by the following claims.

[143] [Description of Reference Numerals]

[144] 110: logistics robot

[145] 140: control device

[146] 150: virtual control device

[147] 151: collection unit

[148] 152: setting unit

[149] 153: determination unit

[150] 154: output unit

CLAIMS

[Claim 1]

A method for virtually controlling a logistics robot, the method comprising:

collecting logistics robot information of a logistics robot and load information of at least one load loaded on the logistics robot;

setting a first virtual area corresponding to an actual occupied space of the logistics robot based on the logistics robot information and the load information;

determining whether an operation control condition of the logistics robot is satisfied based on a positional relationship between the first virtual area and a second virtual area set to correspond to an actual occupied space of another object other than the logistics robot on which the first virtual area is set; and

outputting a control signal for operation control of the logistics robot when the operation control condition is satisfied.

[Claim 2]

The method of claim 1, wherein the first virtual area is set to be at least partially expanded compared to the actual occupied space of the logistics robot.

[Claim 3]

The method of claim 1, wherein the first virtual area is a virtual area on a plane corresponding to the actual occupied space of the logistics robot, and

the operation control condition includes a first operation control condition determined based on a positional relationship between the first virtual area and the second virtual area, and a second operation control condition determined based on three-dimensional shapes of the logistics robot on which the first

virtual area is set and the another object on which the second virtual area is set when the first operation control condition is satisfied.

[Claim 4]

The method of claim 3, wherein the three-dimensional shape of the logistics robot includes a three-dimensional shape of a load loaded on the logistics robot.

[Claim 5]

The method of claim 4, wherein the three-dimensional shape of the load is included in the load information.

[Claim 6]

The method of claim 1, wherein whether the operation control condition is satisfied is determined regardless of whether a communication connection between the logistics robot and the another object is established.

[Claim 7]

The method of claim 1, wherein the virtual area is set in consideration of at least one of a type, a speed, a loading state, position information, and path information of the logistics robot included in the logistics robot information.

[Claim 8]

The method of claim 1, wherein whether the operation control condition is satisfied is determined based on at least one of a degree of overlap and a degree of proximity according to the positional relationship between the first virtual area and the second virtual area.

[Claim 9]

The method of claim 1, wherein the control signal causes at least one of a speed and a movement direction of the logistics robot to be adjusted.

[Claim 10]

The method of claim 1, wherein the outputting the control signal includes outputting the control signal further in consideration of a preset priority between the logistics robot and the another object.

[Claim 11]

A device for virtually controlling a logistics robot, the device comprising:

a collection unit configured to collect logistics robot information of a logistics robot and load information of at least one load loaded on the logistics robot;

a setting unit configured to set a first virtual area corresponding to an actual occupied space of the logistics robot based on the logistics robot information and the load information;

a determination unit configured to determine whether an operation control condition of the logistics robot is satisfied based on a positional relationship between the first virtual area and a second virtual area set to correspond to an actual occupied space of another object other than the logistics robot on which the first virtual area is set; and

an output unit configured to output a control signal for operation control of the logistics robot when the operation control condition is satisfied.

[Claim 12]

The device of claim 11, wherein the first virtual area is set to be at least partially expanded compared to the actual occupied space of the logistics robot.

[Claim 13]

The device of claim 11, wherein the first virtual area is a virtual area on a plane corresponding to the actual occupied space of the logistics robot, and

the operation control condition includes a first operation control condition determined based on a positional relationship between the first virtual area and the second virtual area, and a second operation control condition determined based on three-dimensional shapes of the logistics robot on which the first virtual area is set and the another object on which the second virtual area is set when the first operation control condition is satisfied.

[Claim 14]

The device of claim 13, wherein the three-dimensional shape of the logistics robot includes a three-dimensional shape of a load loaded on the logistics robot.

[Claim 15]

The device of claim 14, wherein the three-dimensional shape of the load is included in the load information.

[Claim 16]

The device of claim 11, wherein whether the operation control condition is satisfied is determined regardless of whether a communication connection between the logistics robot and the another object is established.

[Claim 17]

The device of claim 11, wherein the virtual area is set in consideration of at least one of a type, a speed, a loading state, position information, and path information of the logistics robot included in the logistics robot information.

[Claim 18]

The device of claim 11, wherein whether the operation control condition is satisfied is determined based on at least one of a degree of overlap and a degree of proximity according to the positional relationship between the first virtual area and the second virtual area.

[Claim 19]

The device of claim 11, wherein the control signal causes at least one of a speed and a movement direction of the logistics robot to be adjusted.

[Claim 20]

The device of claim 11, wherein the output unit outputs the control signal further in consideration of a preset priority between the logistics robot and the another object.