

DESCRIPTION

Invention Title: METHOD AND DEVICE FOR VIRTUALLY CONTROLLING LOGISTICS PROCESSES

Technical Field

- [1] The present invention relates to a method and device for virtually controlling logistics processes that perform control over a plurality of operation targets operating within an operation boundary through a virtual environment.

Background Art

- [2] Logistics robots are being introduced for flexible and efficient supply and transport of parts and the like in general logistics warehouses or factories, as well as in smart factories that manufacture products with different specifications using various parts.
- [3] Logistics robot is a concept collectively referring to autonomous mobile robots (AMR: Autonomous Mobile Robot) and automated guided vehicles (AGV: Automated Guided Vehicle), and such logistics robots may perform movement and tasks 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] A plurality of logistics robots may be provided within a smart factory, and when movement paths of the plurality of logistics robots overlap, collision between the logistics robots may occur. For example, when one logistics robot descends and another logistics robot ascends in a narrow passage within a smart factory, these two logistics robots may fall into a deadlock state and collide. Also, a

logistics robot may collide with equipment disposed within the smart factory during a process of moving within the smart factory. Also, even if collision does not occur, situations in which the logistics robot and equipment interfere with each other's operations may also occur.

[6] As such, since various situations may occur during operation of a smart factory, there is a need to propose a measure that enables appropriate and early rapid response to various situations.

[7]

[8] 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 acknowledgment that they correspond to prior art already known to those skilled in the art.

Disclosure

Technical Problem

[9] Accordingly, the present invention has a technical problem of providing a method and device for virtually controlling logistics processes that configures a virtual environment based on information about operation targets operating within an operation boundary and facilitates control over the operation targets through determination of conditions set on the virtual environment.

[10]

[11] The problems of the present invention are not limited to the problems mentioned above, and other problems not mentioned will be clearly understood by those skilled in the art from the description below.

Technical Solution

- [12] A method for virtually controlling logistics processes according to an embodiment of the present invention for solving the problems as described above includes: collecting operation information about a plurality of operation targets disposed and operating within a predetermined operation boundary; generating a virtual map on which a plurality of objects respectively corresponding to at least a portion of the plurality of operation targets are displayed, based on the collected operation information; setting, on the virtual map, a trigger zone that varies based on event operations performed by the plurality of objects, for each of the plurality of objects; determining whether an event occurrence condition is satisfied for each of the plurality of objects based on the operation information, controlling an object for which the event occurrence condition is satisfied among the plurality of objects to perform an event operation corresponding to the event occurrence condition on the virtual map, and determining a positional relationship between an area occupied by each of the plurality of objects on the virtual map according to the event operations of the plurality of objects and the trigger zone; and outputting a signal corresponding to a result of the determination.
- [13] For example, the plurality of operation targets may include at least one of a plurality of equipment disposed within a predetermined operation boundary and a logistics robot moving while passing through at least one of the plurality of equipment within a predetermined operation boundary.
- [14] For example, the operation information may include equipment information about the plurality of equipment, and the equipment information may include at least one of volume information, position information, type information, and operating range information about the plurality of operation targets.

- [15] For example, the operation information may include an operation signal about the plurality of equipment, and the operation signal may be generated corresponding to at least one of operation start, operation end, and abnormality of the plurality of equipment.
- [16] For example, the operation signal may be generated through a PLC (Programmable Logic Controller).
- [17] For example, the operation information may include logistics robot information about the at least one logistics robot, and the logistics robot information may include at least one of movement path information, current position information, operation state information, volume information, and loading state information of the logistics robot.
- [18] For example, the outputting may include determining the positional relationship depending on whether an area occupied by a specific object among the plurality of objects on the virtual map departs from a trigger zone for the specific object.
- [19] For example, the outputting may include determining the positional relationship based on at least one of proximity and overlap degree between an area occupied by a specific object among the plurality of objects on the virtual map and a trigger zone for another object other than the specific object.
- [20] For example, the signal may include at least one of an alarm signal and a control signal for controlling an operation of the operation target.
- [21] For example, the trigger zone may include a plurality of different areas, and the determining may include determining a positional relationship between an area occupied by each of the plurality of objects on the virtual map and the plurality of areas of the trigger zone.

[22]

[23] A device for virtually controlling logistics processes according to an embodiment of the present invention for solving the problems as described above includes: a collection unit configured to collect operation information about a plurality of operation targets disposed and operating within a predetermined operation boundary; a setting unit configured to generate a virtual map on which a plurality of objects respectively corresponding to at least a portion of the plurality of operation targets are displayed based on the operation information, and to set, on the virtual map, a trigger zone that varies based on event operations performed by the plurality of objects, for each of the plurality of objects; a determination unit configured to determine whether an event occurrence condition is satisfied for each of the plurality of objects based on the operation information, to control an object for which the event occurrence condition is satisfied among the plurality of objects to perform an event operation corresponding to the event occurrence condition on the virtual map, and to determine a positional relationship between an area occupied by each of the plurality of objects on the virtual map according to the event operations of the plurality of objects and the trigger zone; and an output unit configured to output a signal corresponding to a result of the determination.

[24] For example, the plurality of operation targets may include at least one of a plurality of equipment disposed within a predetermined operation boundary and a logistics robot moving while passing through at least one of the plurality of equipment within a predetermined operation boundary.

[25] For example, the operation information may include equipment information about the plurality of equipment, and the equipment information may include at least one of

volume information, position information, type information, and operating range information about the plurality of operation targets.

- [26] For example, the operation information may include an operation signal about the plurality of equipment, and the operation signal may be generated corresponding to at least one of operation start, operation end, and abnormality of the plurality of equipment.
- [27] For example, the operation signal may be generated through a PLC (Programmable Logic Controller).
- [28] For example, the operation information may include logistics robot information about the at least one logistics robot, and the logistics robot information may include at least one of movement path information, current position information, operation state information, volume information, and loading state information of the logistics robot.
- [29] For example, the determination unit may determine the positional relationship depending on whether an area occupied by a specific object among the plurality of objects on the virtual map departs from a trigger zone for the specific object.
- [30] For example, the determination unit may determine the positional relationship based on at least one of proximity and overlap degree between an area occupied by a specific object among the plurality of objects on the virtual map and a trigger zone for another object other than the specific object.
- [31] For example, the signal may include at least one of an alarm signal and a control signal for controlling an operation of the operation target.

[32] For example, the trigger zone may include a plurality of different areas, and the determination unit may determine a positional relationship between an area occupied by each of the plurality of objects on the virtual map and the plurality of areas of the trigger zone.

Advantageous Effects

[33] According to the embodiments of the present invention as described above, it becomes possible to configure a virtual environment based on information about operation targets operating within an operation boundary and to facilitate control over the operation targets through determination of conditions set on the virtual environment.

[34] Also, through such control, it becomes possible to prevent delay of an entire process performed through each operation target within the operation boundary.

[35]

[36] 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 those skilled in the art to which the present invention belongs from the description below.

Description of Drawings

[37] FIG. 1 is a block diagram illustrating an example of an operation boundary configuration of a logistics system applicable to embodiments of the present invention.

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

[39] FIG. 3 is a block diagram illustrating an example of a logistics robot configuration applicable to embodiments of the present invention.

[40] FIG. 4 is a sequence diagram of collision prediction according to an embodiment of the present invention.

Mode for Disclosure

[41] The specific structural or functional descriptions of the embodiments of the present invention disclosed in this specification or application are merely illustrated for the purpose of explaining 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 this specification or application.

[42] Since the embodiments according to the present invention may be variously modified and may have various forms, specific embodiments will be illustrated in the drawings and described in detail in this 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, and alternatives included in the spirit and technical scope of the present invention.

[43] In the description of the following embodiments, the term "predetermined" means that a numerical value of a parameter is determined in advance when using the parameter in a process or algorithm. The numerical value of the parameter may be set when the process or algorithm starts or may be set during a period in which the process or algorithm is performed, depending on the embodiment.

[44] Unless otherwise defined, all terms used herein, including technical or scientific terms, have the same meaning as commonly understood by one of ordinary skill in the art 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 art, and should not be interpreted in an ideal or excessively formal sense unless explicitly defined in this specification.

- [45] Hereinafter, embodiments disclosed in this specification will be described in detail with reference to the accompanying drawings, and the same or similar components will be assigned the same reference numerals regardless of drawing numerals, and redundant descriptions thereof will be omitted.
- [46] The suffixes "module" and "unit" for components used in the following description are given or used interchangeably only in consideration of ease of writing the specification, and do not have distinct meanings or roles by themselves.
- [47] In describing the embodiments disclosed in this specification, when it is determined that detailed descriptions of related known technologies may obscure the gist of the embodiments disclosed in this specification, the detailed descriptions thereof will be omitted. Also, the accompanying drawings are only for easily understanding the embodiments disclosed in this specification, and the technical ideas disclosed in this specification are not limited by the accompanying drawings, and should be understood to include all modifications, equivalents, and alternatives included in the spirit and technical scope of the present invention.
- [48] 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.
- [49] When it is mentioned that a certain component is "connected" or "coupled" to another component, it should be understood

that it 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.

[50] Singular expressions include plural expressions unless the context clearly indicates otherwise.

[51] In this specification, terms such as "comprise" or "have" should be understood as designating that a feature, number, step, operation, component, part, or combination thereof described in the specification exists, and do not preclude the possibility of existence or addition of one or more other features, numbers, steps, operations, components, parts, or combinations thereof.

[52]

[53] First, the 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.

[54] Referring to FIG. 1, the operation boundary 100 may include a logistics robot 110, equipment 120, a monitoring device 130, and a control device 140.

[55] The operation boundary 100 may be provided with a plurality of logistics robots 110, a plurality of equipment 120, and a plurality of sensing devices 130 according to a production process and a target production speed of a product. The operation boundary 100 is a smart factory, and the plurality of equipment may be implemented as production devices, but is not necessarily limited thereto. Hereinafter, each component will be described.

[56] 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). Depending on the 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.

- [57] The AGV generally performs required operations (movement, direction change, stop, etc.) within the operation boundary 100 by recognizing and following guidance equipment disposed on the floor for guiding the AGV. Here, the guidance equipment may mean optically recognizable markers (spots, 2D codes, etc.), tags recognizable in a non-contact manner at a short distance (for example, NFC tags, RFID tags, etc.), magnetic strips, wires, etc., but this is exemplary and is not necessarily limited thereto. The guidance equipment may be disposed continuously on the floor or may be disposed discontinuously spaced apart from each other. Since the AGV basically performs operations through recognition and following of the guidance equipment, it requires the guidance equipment to be installed in advance before operation, and when moving the AGV to a new path or modifying an existing path, it is necessary to physically install or modify the guidance equipment. Also, 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 common to stop until the detected obstacle disappears or receives separate control. In operating the AGV, the control device 140 must control the AGV based on the guidance equipment, so it may transmit commands with meanings such as 'drive until the 3rd marker is recognized from the current position', 'change the heading direction by 90 degrees when the 3rd marker is recognized' to the AGV in units of individual commands or

missions (for example, retrieval, supply, charging, patrol, etc.) including a plurality of commands.

[58] The AMR can determine the current position (i.e., localization) through peripheral sensing, and the most distinguishing point from the AGV is that it is capable of self-path setting (path planning) using localization and a map. Therefore, when a map compatible with coordinates is shared between the AMR and the control device 140, the control device 140 can control the AMR by instructing the path to the AMR based on coordinates. Also, when an obstacle is detected during driving, the AMR can set an avoidance path on its own to avoid the obstacle and then return to the original path. The function of the control device 140 setting the path of the AMR with 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.

[59]

[60] Next, the equipment 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 that detects the status of a designated position where a pallet transported by the logistics robot 110 can be put down or collected within an area where a specific production process is performed, a device that determines a process progress, an entry blocking means within an area, etc., but is not necessarily limited thereto.

- [61] For example, the equipment 120 is controlled through a PLC (Programmable Logic Controller) and may communicate with the control device 140 in relation to process progress.
- [62] The monitoring device 130 may perform a function of acquiring information for determining a situation within the operation boundary 100 and transmitting it 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.
- [63] The control device 140 may acquire information necessary for operating the operation boundary 100 or control each component by communicating with the aforementioned components 110, 120, 130. For example, the control device 140 may perform dispatching of the logistics robot 110, path setting, mission assignment, process management for each product, material management, etc.
- [64] In implementation, the control device 140 may include a local control device (ACS: AMR/AGV Control System) that controls peripheral process equipment 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 and path of all logistics robots 110 within the operation boundary 100, logistics flow setting, and traffic control from each of the plurality of local control devices. For example, when the local control device (ACS) is provided in units of logistics robots of the same manufacturer or the same model, the integrated control device may perform integrated control for collision prevention such as bottleneck level analysis of intersection/overlap areas, acceleration/deceleration control of driving, and re-generation of avoidance paths through heterogeneous traffic

dispersion control based on information acquired through the plurality of local control devices (ACS).

- [65] 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).
- [66] In addition to the configuration 110, 120, 130, 140 of the operation boundary 100 described above, devices for mutual communication between each component such as beacons, repeaters, APs (Access Points), chargers for charging the logistics robot 110, loading spaces for storing or loading parts, 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.
- [67] Hereinafter, the configuration of the control device 140 applicable to the embodiments of the present invention will be described with reference to FIG. 2.
- [68]
- [69] FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to the embodiments of the present invention. Each component illustrated in FIG. 2 mainly shows components related to the embodiments of the present invention, and in actual implementation of the control device 140, more or fewer components may be included.
- [70] 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 monitoring unit 147, and a map management unit 148.

- [71] The firmware management unit 141 may acquire the latest firmware of the logistics robot 110 through the communication unit 146 and transmit it to the logistics robot 110 to perform firmware update, thereby maintaining the firmware of the logistics robot 110 in the latest state.
- [72] 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.
- [73] The process management unit 143 may define a process for each product and manage missions such as process progress and progress position.
- [74] The production/logistics management unit 144 may dispatch the logistics robot 110 based on a mission.
- [75] 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 the destination in advance of the time when actual assembly/consumption of the material is detected for pallet pickup or retrieval.
- [76] The communication unit 146 may perform communication with internal components of the operation boundary 100 such as the logistics robot 110, the equipment 120, and the monitoring device 130, as well as external entities such as firmware update servers.
- [77] The monitoring unit 147 may monitor the position, path, battery status, communication status, power train status, etc. of individual logistics robots 110. Here, the path is a concept including a global path based on waypoints and a real-time local path. Also, the battery status 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

status may include information about the currently activated communication protocol (Wi-Fi, etc.), connected AP, distance from AP, channel in use, etc. In addition, the power train status may include load, temperature, RPM, etc. of the driving system.

[78] In addition, the monitoring unit 147 may also check the currently assigned mission, operation mode, firmware version, etc. of individual logistics robots 110.

[79] The map management unit 148 acquires map information in the form of a grid map acquired while the AMR among the logistics robots 110 travels inside the operation boundary 100, and may provide a tool that a factory manager can edit based on the acquired map information. Through editing of map information, zones where one or more preset operations are performed when the logistics robot 110 enters, virtual lanes, intersections, entry prohibited areas, etc. may be set, but this is exemplary and is not necessarily limited thereto. Also, the map management unit 148 may also distribute the map to the remaining logistics robots 110 other than the logistics robot 110 that acquired the initial grid map through actual driving, through the communication unit 146.

[80] Hereinafter, a logistics robot applicable to the embodiments of the present invention will be described.

[81]

[82] FIG. 3 is a block diagram illustrating an example of a logistics robot configuration applicable to the embodiments of the present invention.

[83] 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, and hereinafter, each component will be described.

- [84] The driving unit 111 may include a driving source, wheels, and suspension related to movement, steering, and stopping of the logistics robot 110. An electric motor receiving power from a built-in battery (not shown) may be used as the driving source. The wheels may include one or more driving wheels receiving driving force from the driving source and non-driving wheels rotating 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 can be independently controlled. In this case, by making the rotation directions of different driving wheels different, the vehicle body can be rotated and steered without a separate steering means. At least some of the non-driving wheels may be configured as caster-type wheels, but this is exemplary and is not necessarily limited thereto.
- [85] The sensing unit 112 is for detecting the surrounding environment of the logistics robot 110 or its own operation state, and may include at least one of a 2D laser scanner (for example, LiDAR), a 3D vision (stereo) camera, a multi-axis gyro sensor, an acceleration sensor, a wheel encoder, and a proximity sensor.
- [86] The encoder may output information capable of determining how much the wheel has rotated using light emitted from a light emitting element (for example, a 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 is capable of performing odometry to estimate displacement by analyzing the amount of position change over time with data acquired through the encoder and the gyro sensor. However, due to wheel slip or wear (change in wheel radius), the displacement estimated based on encoder data may have errors from the actual displacement.

Therefore, when performing odometry, the control unit 115 may output a result with a tendency close to the actual value by performing correction for noise and errors with information collected from the wheel and the gyro sensor using a predetermined algorithm (for example, EKF: Extended Kalman Filter). Such odometry may be particularly useful when current position determination (Localization) using a 2D laser scanner described later is not possible.

- [87] The 2D laser scanner may scan the surrounding environment by irradiating a laser to the surroundings through a rotating reflector and detecting signals reflected back. At this time, it may output a detection result in the form of a point cloud by analyzing the intensity of the reflected signal and the time difference between irradiation and reception.
- [88] 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 flat objects of the same color (for example, a white wall).
- [89] In general, a 2D laser scanner is used for mapping, navigation, object recognition, etc., and a 3D camera may be utilized especially for obstacle avoidance during navigation, but this is exemplary and is not necessarily limited thereto.
- [90] The loading unit 113 is a means for loading items to be transported, and may be a top plate on the upper part of the vehicle body itself or a table, lift, turntable rotating along a vertical axis, forklift, conveyor, or a combination thereof disposed on the top plate. In the case

of a forklift, similar to a forklift truck, it may support telescopic and tilting functions.

[91] The communication unit 114 may communicate with other components within the operation boundary 100 such as the equipment 120 and the control device 140, and may also support communication between logistics robots 110, and communication with a charger is also possible when performing a charging mission.

[92]

[93] FIG. 4 is a sequence diagram of collision prediction according to an embodiment of the present invention.

[94] Referring to FIG. 4, a virtual control device 200 according to an embodiment of the present invention may include a collection unit 210, a setting unit 220, a determination unit 230, and an output unit 240, and may interact with the logistics robot 110, the equipment 120, and the control device 140. The virtual control device 200 may be implemented within the operation boundary 100 or may be implemented outside the operation boundary 100. However, FIG. 4 mainly shows components related to the description of an embodiment of the present invention, and the actual collision prediction device may be implemented including more or fewer components. Hereinafter, each configuration and detailed functions performed by each configuration will be described in detail.

[95]

[96] First, the setting unit 220 may generate and distribute a virtual map on which a plurality of objects respectively corresponding to at least a portion of a plurality of operation targets disposed and operating within the predetermined operation boundary 100 are displayed in step S401. In this case, the virtual map may be generated based on operation information about the plurality of operation

targets and may be implemented as a 3D map having 3-axis coordinates. Also, objects corresponding to each of the plurality of operation targets may be visually represented on the virtual map.

- [97] Also, the setting unit 220 may set a trigger zone for each of the plurality of objects on the virtual map in step S402. Here, the trigger zone may vary based on event operations performed by the plurality of objects, and may be set to indicate a range in which each of the plurality of objects can normally operate.
- [98] Meanwhile, the collection unit 210 may collect operation information about the plurality of operation targets. In this case, the plurality of operation targets may include at least one of a plurality of equipment 120 disposed within the predetermined operation boundary 100 and a logistics robot 110 moving while passing through at least one of the plurality of equipment 120. The operation information may include equipment information about the plurality of equipment 120 and logistics robot information about the at least one logistics robot 110.
- [99] More specifically, the logistics robot information may include at least one of movement path information, current position information, operation state information, and loading state information of the logistics robot 110. Such logistics robot information may be collected from the control device 140 in step S403. In this case, the control device 140 may transmit information collected from the logistics robot 110 to the collection unit 210. However, the logistics robot information does not necessarily have to be collected in this way, and the collection unit 210 may also collect logistics robot information directly from the logistics robot 110.
- [100] Meanwhile, the equipment information may include at least one of volume information, position information, type

information, and operating range information about the plurality of equipment 120. Also, the equipment information may include an operation signal about the equipment 120, and in this case, the operation signal may be generated corresponding to at least one of operation start, operation end, and abnormality of the equipment 120, and for example, may be generated through a PLC (Programmable Logic Controller).

[101] Such equipment information may be transmitted from the equipment 120 to the collection unit 210 in step S404. However, it is not necessarily limited thereto, and the collection unit 210 may also acquire equipment information from the control device 140 that controls the plurality of equipment 120.

[102] Also, the operation information may additionally include monitoring information of the sensing device 130. The monitoring information may include, for example, sensing results about the logistics robot 110 and the equipment 120 collected through sensors such as cameras within the operation boundary 100. The collection unit 210 may acquire such monitoring information from the monitoring device 130.

[103]

[104] Meanwhile, the determination unit 230 may configure an event operation of an object on the virtual map through the operation information collected as described above and the set virtual map in step S407. More specifically, the determination unit 230 may determine whether an event occurrence condition is satisfied for each of the plurality of objects based on the operation information, and may control an object for which the event occurrence condition is satisfied to perform an event operation corresponding to the event occurrence condition on the virtual map.

- [105] More specifically, the event occurrence condition may be set differently for each of the plurality of objects, and each object may perform different event operations.
- [106] For example, the plurality of different event occurrence conditions may include a first condition satisfied when an operation signal corresponding to operation start of specific equipment 120 is input, a second condition satisfied when an operation signal corresponding to operation end of specific equipment 120 is input, etc. In this case, the event operation may correspond to an operation of a task performed by the equipment 120 corresponding to the object within the operation boundary 100, and when the first condition is satisfied in the case where the specific equipment 120 is equipment 120 that performs a task of lifting an item in front through a robot arm, the determination unit 230 may control an object corresponding to the specific equipment 120 to perform an event operation corresponding to the task of lifting an item in front through a robot arm on the virtual map.
- [107] When such an event operation is performed, characteristics of the object performing the event operation on the virtual map may change, and for example, the shape or position of the object may change on the virtual map. In this case, the area occupied by the object on the virtual map changes.
- [108] The determination unit 230 may determine an output signal based on the positional relationship between the area occupied by the object on the virtual map according to the event operation as described above and the set trigger zone in step S408.
- [109] More specifically, the determination unit 230 may determine the positional relationship depending on whether an area occupied by a specific object among the plurality

of objects on the virtual map departs from a trigger zone for the specific object, and may determine an output signal. For example, for specific equipment 120, a range in which the specific equipment 120 can safely operate may be set as a trigger zone, and in this case, it may be determined whether the area occupied by the object corresponding to the specific equipment 120 on the virtual map departs from the trigger zone according to occurrence of an event operation, and through this, it becomes possible to determine whether the actual specific equipment 120 is operating within a range in which it can safely operate.

[110] Also, for a specific logistics robot 110, a range in which the logistics robot 110 can safely interact with the equipment 120 may be set as a trigger zone, and in this case, it may be determined whether the area occupied by the object corresponding to the specific logistics robot 110 on the virtual map departs from the trigger zone according to occurrence of an event operation, and through this, it becomes possible to determine whether the logistics robot 110 is operating within a range in which it can safely interact with the equipment 120 without colliding.

[111] Meanwhile, the determination unit 230 may also determine the positional relationship based on at least one of proximity and overlap degree between an area occupied by a specific object among the plurality of objects on the virtual map and a trigger zone for another object other than the specific object.

[112] For example, in the relationship between a specific object corresponding to the logistics robot 110 and an object for the equipment 120, the trigger zone may be set as an interlock area in which the operation of the equipment 120 is started or stopped when the logistics robot 110 enters or exits. In this case, it becomes possible to determine whether an interlock condition for

controlling the equipment 120 is satisfied according to proximity or overlap degree between the specific object corresponding to the logistics robot 110 and the trigger zone of another object corresponding to the equipment 120.

[113] Also, in this case, the trigger zone may also be set as a safety range for collision avoidance, and when the area occupied by a specific object on the virtual map intrudes on (i.e., overlaps with) or is proximate to the trigger zone of another object, it becomes possible to determine whether measures for collision avoidance between operation targets respectively corresponding to the specific object and another object are necessary.

[114] Such determination results are transmitted to the output unit 240, and the output unit 240 outputs an output signal determined based on the event operation and the trigger zone in the determination unit 230.

[115] In this case, the signal output from the output unit 240 may include an alarm signal and a control signal, and in the case of an alarm signal, it may be implemented as an interlock condition satisfaction signal, a collision avoidance request signal, etc. and transmitted to the control device 140, and the control device 140 may perform follow-up measures corresponding to the alarm signal or notify a user, etc.

[116] Also, the control signal is a signal for controlling an operation target, and may be transmitted to each of the plurality of equipment 120 or the logistics robot 110 depending on the target of control in step S410. For example, the control signal may include a signal for causing the equipment 120 or the logistics robot 110 to perform operations such as deceleration, stop, detour for collision avoidance, a signal for causing the equipment 120 to perform a specific operation according to satisfaction of an interlock condition, etc.

[117] Meanwhile, the output unit 240 may also visualize and output the virtual map in real time, and may include or be connected to a display device, etc. for this purpose. On the virtual map output through the output unit 240, coordinates, event operations, occupied areas, trigger zones, etc. of each object may be represented.

[118]

[119] Meanwhile, in an embodiment, the setting unit 220 may also set the trigger zone to include a plurality of different areas, and in this case, the determination unit 230 may cause different signals to be output depending on which area of the trigger zone the area occupied by a specific object on the virtual map overlaps with or is proximate to.

[120] For example, the plurality of areas may include a first area and a second area, and when the area occupied by an object corresponding to a specific logistics robot 110 on the virtual map overlaps with the first area of the trigger zone for another object, an alarm signal of a level notifying that the logistics robot 110 is proximate to another operation target may be output. In contrast, when the area occupied by an object corresponding to a specific logistics robot 110 on the virtual map overlaps with the second area of the trigger zone for another object, a control signal for controlling the speed and movement direction of the logistics robot 110 so that the logistics robot 110 does not collide with another operation target may be output.

[121]

[122] To perform the functions as described above, the collision prediction device 200 may be implemented including a communication device communicating with a controller or sensors, a memory storing an operating system,

logic instructions, input/output information, etc., and one or more processors performing determination, calculation, decision, etc. necessary for controlling the assigned function.

[123]

[124] According to the embodiments of the present invention as described above, it becomes possible to configure a virtual environment based on information about operation targets operating within an operation boundary and to facilitate control over the operation targets through determination of conditions set on the virtual environment.

[125]

[126] Also, through such control, it becomes possible to prevent delay of an entire process performed through each operation target within the operation boundary.

[127]

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

[129] [Description of Reference Numerals]

[130] 100: operation boundary

[131] 110: logistics robot

[132] 120: equipment

[133] 130: monitoring device

[134] 140: control device

[135] 200: collision prediction device

CLAIMS

[Claim 1]

A method for virtually controlling logistics processes, the method comprising:

collecting operation information about a plurality of operation targets disposed and operating within a predetermined operation boundary;

generating a virtual map on which a plurality of objects respectively corresponding to at least a portion of the plurality of operation targets are displayed, based on the collected operation information;

setting, on the virtual map, a trigger zone that varies based on event operations performed by the plurality of objects, for each of the plurality of objects;

determining whether an event occurrence condition is satisfied for each of the plurality of objects based on the operation information, controlling an object for which the event occurrence condition is satisfied among the plurality of objects to perform an event operation corresponding to the event occurrence condition on the virtual map, and determining a positional relationship between an area occupied by each of the plurality of objects on the virtual map according to the event operations of the plurality of objects and the trigger zone; and

outputting a signal corresponding to a result of the determination.

[Claim 2]

The method of claim 1, wherein the plurality of operation targets include at least one of a plurality of equipment disposed within a predetermined operation boundary and a logistics robot moving through at least one of the plurality of equipment within a predetermined operation boundary.

[Claim 3]

The method of claim 2, wherein the operation information includes equipment information about the plurality of equipment, and the equipment information includes at least one of volume information, position information, type information, and operating range information about the plurality of equipment.

[Claim 4]

The method of claim 2, wherein the operation information includes an operation signal about the plurality of equipment, and the operation signal is generated corresponding to at least one of operation start, operation end, and abnormality of the plurality of equipment.

[Claim 5]

The method of claim 4, wherein the operation signal is generated through a PLC (Programmable Logic Controller).

[Claim 6]

The method of claim 2, wherein the operation information includes logistics robot information about the at least one logistics robot, and the logistics robot information includes at least one of movement path information, current position information, operation state information, volume information, and loading state information of the logistics robot.

[Claim 7]

The method of claim 1, wherein the outputting includes determining the positional relationship depending on whether an area occupied by a specific object among the plurality of objects on the virtual map departs from a trigger zone for the specific object.

[Claim 8]

The method of claim 1, wherein the outputting includes determining the positional relationship based on at least one of

proximity and overlap degree between an area occupied by a specific object among the plurality of objects on the virtual map and a trigger zone for another object other than the specific object.

[Claim 9]

The method of claim 1, wherein the signal includes at least one of an alarm signal and a control signal for controlling an operation of the operation target.

[Claim 10]

The method of claim 1, wherein the trigger zone includes a plurality of different areas, and the determining includes determining a positional relationship between an area occupied by each of the plurality of objects on the virtual map and the plurality of areas of the trigger zone.

[Claim 11]

A device for virtually controlling logistics processes, the device comprising:

a collection unit configured to collect operation information about a plurality of operation targets disposed and operating within a predetermined operation boundary;

a setting unit configured to generate a virtual map on which a plurality of objects respectively corresponding to at least a portion of the plurality of operation targets are displayed based on the operation information, and to set, on the virtual map, a trigger zone that varies based on event operations performed by the plurality of objects, for each of the plurality of objects;

a determination unit configured to determine whether an event occurrence condition is satisfied for each of the plurality of objects based on the operation information, to control an object for which the event occurrence condition is satisfied among the plurality of objects to perform an event

operation corresponding to the event occurrence condition on the virtual map, and to determine a positional relationship between an area occupied by each of the plurality of objects on the virtual map according to the event operations of the plurality of objects and the trigger zone; and

an output unit configured to output a signal corresponding to a result of the determination.

[Claim 12]

The device of claim 11, wherein the plurality of operation targets include at least one of a plurality of equipment disposed within a predetermined operation boundary and a logistics robot moving through at least one of the plurality of equipment within a predetermined operation boundary.

[Claim 13]

The device of claim 12, wherein the operation information includes equipment information about the plurality of equipment, and the equipment information includes at least one of volume information, position information, type information, and operating range information about the plurality of equipment.

[Claim 14]

The device of claim 12, wherein the operation information includes an operation signal about the plurality of equipment, and the operation signal is generated corresponding to at least one of operation start, operation end, and abnormality of the plurality of equipment.

[Claim 15]

The device of claim 14, wherein the operation signal is generated through a PLC (Programmable Logic Controller).

[Claim 16]

The device of claim 12, wherein the operation information includes logistics robot information about the at least one

logistics robot, and the logistics robot information includes at least one of movement path information, current position information, operation state information, volume information, and loading state information of the logistics robot.

[Claim 17]

The device of claim 11, wherein the determination unit determines the positional relationship depending on whether an area occupied by a specific object among the plurality of objects on the virtual map departs from a trigger zone for the specific object.

[Claim 18]

The device of claim 11, wherein the determination unit determines the positional relationship based on at least one of proximity and overlap degree between an area occupied by a specific object among the plurality of objects on the virtual map and a trigger zone for another object other than the specific object.

[Claim 19]

The device of claim 11, wherein the signal includes at least one of an alarm signal and a control signal for controlling an operation of the operation target.

[Claim 20]

The device of claim 1, wherein the trigger zone includes a plurality of different areas, and the determination unit determines a positional relationship between an area occupied by each of the plurality of objects on the virtual map and the plurality of areas of the trigger zone.