DESCRIPTION

Title of Invention

CONTROL METHOD, PROGRAM, AND MOVING BODY

Technical Field

[0001]

The present disclosure relates to a control method, a program, and a moving body.

Background Art

[0002]

A moving body including a sensor that detects surroundings and configured to automatically move is known. For example, PTL 1 describes that an obstacle is detected, a position and an orientation of a front surface of the obstacle are identified based on a detection result for the obstacle, and an avoidance path for avoiding the obstacle is generated based on an identification result.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2022-141380

Summary of Invention

Technical Problem

[0004]

Here, there is room for improvement in controlling the moving body so as to

avoid the obstacle.

[0005]

The present disclosure is to solve the above-described problem, and an object thereof is to provide a control method, a program, and a moving body capable of appropriately avoiding an obstacle.

Solution to Problem

[0006]

The present disclosure relates to a control method of a moving body that automatically moves, the control method including: a step of moving the moving body along a reference path; a step of causing a sensor provided on the moving body to detect an obstacle located on a side toward a first direction that is a traveling direction of the moving body when the moving body is moving along the reference path; a step of setting an avoidance path that extends toward the first direction while avoiding the obstacle in a case where the obstacle is present on the side toward the first direction; a step of moving the moving body along the avoidance path; a step of determining whether or not an updated avoidance path that is another avoidance path satisfying a predetermined condition is generatable when the moving body is moving along the avoidance path; and a step of reversing the moving body in a second direction opposite to the first direction in a case where the updated avoidance path satisfying the predetermined condition is not generatable.

[0007]

The present disclosure relates to a program for causing a computer to execute a control method of a moving body that automatically moves, the program causing the computer to execute: a step of moving the moving body along a reference path; a step of causing a sensor provided on the moving body to detect an obstacle located on a side

toward a first direction that is a traveling direction of the moving body when the moving body is moving along the reference path; a step of setting an avoidance path that extends toward the first direction while avoiding the obstacle in a case where the obstacle is present on the side toward the first direction; a step of moving the moving body along the avoidance path; a step of determining whether or not an updated avoidance path that is another avoidance path satisfying a predetermined condition is generatable when the moving body is moving along the avoidance path; and a step of reversing the moving body in a second direction opposite to the first direction in a case where the updated avoidance path satisfying the predetermined condition is not generatable.

[0008]

The present disclosure relates to a moving body that automatically moves, including: a movement control unit that moves the moving body along a reference path; a detection control unit that causes a sensor provided on the moving body to detect an obstacle located on a side toward a first direction that is a traveling direction of the moving body when the moving body is moving along the reference path; and an avoidance path acquisition unit that acquires an avoidance path that extends toward the first direction while avoiding the obstacle in a case where the obstacle is present on the side toward the first direction, in which the movement control unit moves the moving body along the avoidance path, and reverses the moving body in a second direction opposite to the first direction in a case where an updated avoidance path that is a different avoidance path satisfying a predetermined condition is not generatable when the moving body is moving along the avoidance path.

Advantageous Effects of Invention

[0009]

According to the present disclosure, the obstacle can be appropriately avoided.

Brief Description of Drawings

[0010]

FIG. 1 is a schematic diagram of a movement control system according to the present embodiment.

FIG. 2 is a schematic diagram of a configuration of a moving body.

FIG. 3 is a schematic block diagram of a management device.

FIG. 4 is a schematic block diagram of an information processing device.

FIG. 5 is a schematic block diagram of a control device of the moving body.

FIG. 6 is a schematic diagram showing an example of detection of an obstacle.

FIG. 7 is a schematic diagram showing an example of stopping of the moving body.

FIG. 8 is a schematic diagram showing an example of a reverse path.

FIG. 9 is a schematic diagram showing an example of an avoidance path.

FIG. 10 is a schematic diagram showing an example of a case where an updated avoidance path cannot be set.

FIG. 11 is a schematic diagram showing an example of a case where the updated avoidance path cannot be set.

FIG. 12 is a schematic diagram showing an example of a case where the updated avoidance path cannot be set.

FIG. 13 is a schematic diagram showing an example of a retract path.

FIG. 14 is a schematic diagram showing an example of an update of a reference path.

FIG. 15 is a flowchart showing a control flow of the moving body.

FIG. 16 is a schematic diagram showing an example of a method of setting subgoals.

FIG. 17 is a schematic diagram showing an example of the method of setting the subgoals.

FIG. 18 is a schematic diagram showing an example of the method of setting the subgoals.

FIG. 19 is a schematic diagram showing an example of setting of a basis path.

FIG. 20 is a schematic diagram showing an example of setting of the avoidance path.

FIG. 21 is a schematic diagram showing setting of a non-interference region.

FIG. 22 is a schematic diagram showing the setting of the non-interference region.

FIG. 23 is a schematic diagram showing another example of the setting of the non-interference region.

FIG. 24 is a schematic diagram showing an example of a method of extracting a point cloud for analysis.

FIG. 25 is a schematic diagram showing an avoidance path of another moving body.

Description of Embodiments

[0011]

Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. The present disclosure is not limited to the following embodiments, and includes, in a case where there are a plurality of embodiments, a configuration in which the embodiments are combined.

[0012]

(First Embodiment)

(Movement Control System)

FIG. 1 is a schematic diagram of a movement control system according to the present embodiment. As shown in FIG. 1, a movement control system 1 according to the present embodiment includes a moving body 10, a management device 12, and an information processing device 14. The movement control system 1 is a system that controls movement of the moving body 10 belonging to a facility W. The facility W is, for example, a facility managed for logistics, such as a warehouse, but may be any facility as long as the moving body 10 is operated. In the movement control system 1, the moving body 10 picks up and transports an object disposed within a region AR of the facility W. The region AR is a region in which the object is placed or the moving body 10 moves, and is, for example, a floor surface of the facility W. In the present embodiment, the object transported by the moving body 10 is a transport object with cargo loaded on a pallet. However, the object is not limited to the object with cargo loaded on the pallet, and may be in any form, for example, an object with only the cargo without the pallet. In addition, the moving body 10 is not limited to the moving body that transports the object, and may be a device that moves in the facility W for any purpose.

[0013]

Hereinafter, one direction along the region AR will be referred to as an X direction, and a direction along the region AR, which intersects the direction X, will be referred to as a Y direction. In the present embodiment, the Y direction is a direction orthogonal to the X direction. The X direction and the Y direction may be directions along a horizontal plane. In addition, a direction orthogonal to the X direction and the Y direction, more specifically, a direction toward an upper side in a vertical direction, will be referred to as a Z direction. Further, in the present embodiment, unless otherwise noted, the term "position" refers to a position (coordinates) in a coordinate

system (coordinate system of the region AR) on a two-dimensional plane in the region AR. In addition, unless otherwise noted, the term "orientation (direction)" of the moving body 10 or the like refers to an orientation of the moving body 10 or the like in the coordinate system of the region AR, and indicates a yaw angle (rotation angle) of the moving body 10 in a case where the X direction is set to 0° when the moving body 10 or the like is viewed in the Z direction.

[0014]

(Waypoint)

In the region AR, a waypoint WP is set for each position (coordinates). A path (reference path R0 described later) along which the moving body 10 moves is set to connect the waypoints WP. That is, a path that connects the waypoints WP through which the moving body 10 is scheduled to pass is the reference path R0 of the moving body 10. The waypoint WP is set in accordance with a layout of the facility W. The waypoints WP are set, for example, in a matrix in the region AR.

[0015]

(Moving Body)

FIG. 2 is a schematic diagram of a configuration of the moving body. The moving body 10 is a device that can automatically move. In the present embodiment, the moving body 10 is a nonholonomic system that cannot move laterally. In the present embodiment, the moving body 10 is a device that can transport a target object. Additionally, in the present embodiment, the moving body 10 is a forklift, and is, more specifically, a so-called automated guided vehicle (AGV) or an automated guided forklift (AGF). However, the moving body 10 is not limited to the forklift that transports the target object, and may be any device that can automatically move.

[0016]

As shown in FIG. 2, the moving body 10 includes a vehicle body 20, wheels 20A, straddle legs 21, a mast 22, a fork 24, sensors 26A, and a control device 28. The straddle legs 21 are a pair of shaft-shaped members provided at one end portion of the vehicle body 20 in a front-rear direction and protruding from the vehicle body 20. The wheels 20A are provided at tips of the straddle legs 21 and on the vehicle body 20. That is, three wheels 20A are provided in total, but the positions and the number of wheels 20A may be arbitrary. The mast 22 is mounted on the straddle legs 21 so as to be movable, and moves in the front-rear direction of the vehicle body 20. The mast 22 extends along an up-down direction (here, the Z direction) orthogonal to the front-rear direction. The fork 24 is mounted on the mast 22 to be movable in the Z direction. The fork 24 may also be able to move relative to the mast 22 in a lateral direction (direction intersecting the up-down direction and the front-rear direction) of the vehicle body 20. The fork 24 has a pair of forks 24A and 24B. The forks 24A and 24B extend from the mast 22 toward the front direction of the vehicle body 20. The fork 24A and the fork 24B are disposed spaced apart from each other in a lateral direction of the mast 22. Hereinafter, in the front-rear direction, a direction on a side on which the fork 24 is not provided in the moving body 10 will be referred to as a front direction, and a direction on a side on which the fork 24 is provided will be referred to as a rear direction.

[0017]

The sensor 26A detects at least one of a position and an orientation of the object present around the vehicle body 20. It may also be said that the sensor 26A detects at least one of the position of the object relative to the moving body 10 and the orientation of the object relative to the moving body 10. In the present embodiment, the sensors 26A are provided at the tips of the straddle legs 21 in the front direction and on a rear direction side of the vehicle body 20. However, the positions at which the sensors 26A

are provided are not limited to this example, and the sensors 26A may be provided at any position, and the number of sensors 26A provided may also be arbitrary.

[0018]

The sensor 26A is, for example, a sensor that emits laser light. The sensor 26A emits the laser light while performing scanning in one direction (here, the lateral direction), and detects the position and the orientation of the object based on reflected light of the emitted laser light. That is, the sensor 26A may be regarded as a so-called two-dimensional (2D)-light detection and ranging (LiDAR) sensor. However, the sensor 26A is not limited to the above-described sensor and may be a sensor that detects the object using any method. The sensor 26A may be, for example, a so-called three-dimensional (3D)-LiDAR that performs scanning in a plurality of directions, a so-called one-dimensional (1D)-LiDAR that does not perform scanning, or a camera.

[0019]

The control device 28 controls the movement of the moving body 10. The control device 28 will be described later.

[0020]

(Management Device)

FIG. 3 is a schematic block diagram of the management device. The management device 12 is a system that manages logistics in the facility W. Although the management device 12 is a warehouse control system (WCS) or a warehouse management system (WMS) in the present embodiment, the management device 12 is not limited to the WCS and the WMS, and may be any system, for example, a back-end system such as another production management system. The position at which the management device 12 is provided is arbitrary, and the management device 12 may be provided in the facility W or may be provided at a position remote from the facility W

and manage the facility W from the remote position. The management device 12 is a computer and includes a communication unit 30, a storage unit 32, and a control unit 34 as shown in FIG. 3.

[0021]

The communication unit 30 is a module used by the control unit 34 for communicating with an external device such as the information processing device 14, and may include, for example, an antenna and the like. Although a communication method using the communication unit 30 is wireless communication in the present embodiment, the communication method may be arbitrary. The storage unit 32 is a memory that stores various types of information such as processing contents and programs of the control unit 34, and includes, for example, at least one of a main storage device, such as a random-access memory (RAM) or a read-only memory (ROM), and an external storage device, such as a hard disk drive (HDD).

[0022]

The control unit 34 is an arithmetic device and includes, for example, an arithmetic circuit such as a central processing unit (CPU). The control unit 34 includes a movement destination information setting unit 40. The control unit 34 reads out the program (software) from the storage unit 32 and executes the program to implement the movement destination information setting unit 40, and executes processing of the movement destination information setting unit 40. The control unit 34 may execute the processing with a single CPU, or may be provided with a plurality of CPUs and execute the processing with the plurality of CPUs. In addition, the movement destination information setting unit 40 may be implemented by a hardware circuit. Furthermore, a program for the control unit 34 stored in the storage unit 32 may be stored in a recording medium that is readable by the management device 12.

[0023]

The movement destination information setting unit 40 sets movement destination information indicating a movement destination of the moving body 10. The setting of the movement destination information will be described later.

[0024]

The management device 12 may execute processing other than the processing of setting the movement destination information. For example, the management device 12 may also set information for controlling a mechanism (for example, an elevator, a door, or the like) other than the moving body 10 provided in the facility W.

[0025]

(Information Processing Device)

FIG. 4 is a schematic block diagram of the information processing device. The information processing device 14 is a device that is provided in the facility W and that processes information on the movement of the moving body 10. The information processing device 14 is, for example, a fleet control system (FCS), but is not limited to this, and may be any device that processes the information on the movement of the moving body 10. The information processing device 14 is a computer and includes a communication unit 50, a storage unit 52, and a control unit 54 as shown in FIG. 4. The communication unit 50 is a module used by the control unit 54 and communicating with an external device such as the management device 12 and the moving body 10, and may include, for example, an antenna and the like. A communication method using the communication unit 50 is wireless communication in the present embodiment, but the communication method may be arbitrary. The storage unit 52 is a memory that stores various types of information such as processing contents and programs of the control unit 54, and includes, for example, at least one of a main storage device, such as

a RAM or a ROM, and an external storage device, such as an HDD.

[0026]

The control unit 54 is an arithmetic device and includes, for example, an arithmetic circuit such as a CPU. The control unit 54 includes a reference path setting unit 60. The control unit 54 reads out the program (software) from the storage unit 52 and executes the program to implement the reference path setting unit 60, and executes processing of the reference path setting unit 60. The control unit 54 may execute the processing with one CPU, or may be provided with a plurality of CPUs and execute the processing with the plurality of CPUs. Further, at least a part of the reference path setting unit 60 may be implemented by a hardware circuit. Furthermore, a program for the control unit 54 stored in the storage unit 52 may be stored in a recording medium that is readable by the information processing device 14.

[0027]

The reference path setting unit 60 sets a reference path R0 of the moving body 10. A method of setting the reference path R0 will be described later.

[0028]

In the present embodiment, the management device 12 and the information processing device 14 are separate devices, but may be integrated into one device. That is, the management device 12 may incorporate at least some functions of the information processing device 14, and the information processing device 14 may incorporate at least some functions of the management device 12.

[0029]

(Control Device of Moving Body)

Hereinafter, the control device 28 of the moving body 10 will be described. FIG. 5 is a schematic block diagram of the control device of the moving body. The

control device 28 is a device that controls the moving body 10. The control device 28 is a computer and includes a communication unit 70, a storage unit 72, and a control unit 74 as shown in FIG. 5. The communication unit 70 is a module used by the control unit 74 and communicating with an external device such as the information processing device 14, and may include, for example, an antenna and the like. A communication method using the communication unit 70 is wireless communication in the present embodiment, but the communication method may be arbitrary. The storage unit 72 is a memory that stores various types of information such as processing contents and programs of the control unit 74, and includes, for example, at least one of a main storage device, such as a RAM or a ROM, and an external storage device, such as an HDD.

[0030]

The control unit 74 is an arithmetic device and includes, for example, an arithmetic circuit such as a CPU. The control unit 74 includes a reference path acquisition unit 80, a movement control unit 82, a detection control unit 84, a reverse path acquisition unit 86, and an avoidance path acquisition unit 88. The control unit 74 reads out the program (software) from the storage unit 72 and executes the program to implement the reference path acquisition unit 80, the movement control unit 82, the detection control unit 84, the reverse path acquisition unit 86, and the avoidance path acquisition unit 88, and executes processing of the reference path acquisition unit 80, the movement control unit 82, the detection control unit 84, the reverse path acquisition unit 86, and the avoidance path acquisition unit 88. The control unit 74 may execute the processing with one CPU, or may be provided with a plurality of CPUs and execute the processing with the plurality of CPUs. Further, at least a part of the reference path acquisition unit 80, the movement control unit 82, the detection control unit 84, the reverse path acquisition unit 86, and the avoidance path acquisition unit 88 may be

implemented by a hardware circuit. Furthermore, a program for the control unit 74 stored in the storage unit 72 may be stored in a recording medium that is readable by the control device 28.

[0031]

The reference path acquisition unit 80 acquires information on the reference path R0. The movement control unit 82 controls a movement mechanism of the moving body 10, such as a drive unit or steering, to control the movement of the moving body 10. The detection control unit 84 acquires a detection result for an obstacle P from the sensor 26A. The reverse path acquisition unit 86 acquires a reverse path R1 for the moving body 10 to reverse when the obstacle P is detected. The avoidance path acquisition unit 88 acquires an avoidance path R2 for the moving body 10 to travel while avoiding the obstacle P after the moving body 10 reverses along the reverse path R1. The specific processing details thereof will be described later.

[0032]

(Processing of Movement Control System)

Hereinafter, the processing details of the movement control system 1 will be described.

[0033]

(Setting of Movement Destination Information)

The movement destination information setting unit 40 of the management device 12 sets the movement destination information indicating the movement destination of the moving body 10. In the present embodiment, the waypoint is set in advance for each position (coordinates) in the region AR. The movement destination information setting unit 40 may designate the position (coordinates) of the waypoint corresponding to the movement destination itself as the movement destination

information. In addition, an identifier may be assigned to each of the waypoints, and the movement destination information setting unit 40 may designate an identifier of the waypoint corresponding to the movement destination as the movement destination information. The movement destination information setting unit 40 may set the movement destination information by any method. For example, the movement destination information setting unit 40 may acquire order information indicating the target object to be transported, a transport source, and a transport destination, and set the movement destination information based on the order information. The movement destination information setting unit 40 transmits the set movement destination information to the information processing device 14 via the communication unit 30.

[0034]

(Setting of Reference Path)

The reference path setting unit 60 of the information processing device 14 sets a reference path R0a of the moving body 10. In the present embodiment, the reference path setting unit 60 sets the reference path R0a based on the movement destination information. Specifically, the reference path setting unit 60 sets a path passing through each position within a predetermined distance range from each waypoint from a movement source to the movement destination as the reference path R0a. A position of the movement source may be arbitrarily set, and, for example, the waypoint closest to a current position of the moving body 10 may be set as the movement source. For example, the reference path setting unit 60 sets the path passing through each position within the predetermined distance range from each waypoint from an initial position to the movement destination as the reference path R0a, based on the movement destination information and map information of the facility W.

[0035]

The reference path setting unit 60 transmits information on the set reference path R0a to the moving body 10. The reference path acquisition unit 80 of the moving body 10 acquires the information on the reference path R0a set by the information processing device 14. The moving body 10 moves along the reference path R0a. However, the reference path acquisition unit 80 of the moving body 10 may, based on the reference path R0a and information on vehicle specifications of the moving body 10, set a reference path R0b that the moving body 10 can follow as the reference path that the moving body 10 actually follows. In this case, the moving body 10 moves along the reference path R0b. The information on the vehicle specifications is, for example, specifications that affect a path along which the moving body 10 can move, such as a size or a minimum turning radius of the moving body 10. The expression "move along the reference path" does not necessarily mean moving strictly on the reference path, but means moving so as to follow the reference path as closely as possible, and includes movement at positions slightly offset from the reference path. The same applies to paths other than the reference path.

[0036]

In the above description, the information processing device 14 sets the reference path R0a, and the moving body 10 sets the reference path R0b, but the reference paths R0a and R0b may be set by any entity. For example, the moving body 10 may set the reference path R0a, or the information processing device 14 may set the reference path R0b.

[0037]

Hereinafter, in a case where the reference path R0a and the reference path R0b are not distinguished from each other, in other words, in a case where either the reference path R0a or the reference path R0b may be referred to, the reference path will be referred

to as the reference path R0 as appropriate.

[0038]

(Movement of Moving Body)

The movement control unit 82 of the moving body 10 moves the moving body 10 along the acquired reference path R0. The movement control unit 82 sequentially ascertains position information of the moving body 10 to move the moving body 10 to pass through the reference path R0. A method of acquiring the position information of the moving body 10 is arbitrary, but, for example, in the present embodiment, a detection body (not shown) is provided in the facility W, and the movement control unit 82 acquires the information on the position and the orientation of the moving body 10 based on the detection of the detection body. Specifically, the moving body 10 emits the laser light toward the detection body, receives the reflected light of the laser light reflected by the detection body, and detects its own position and orientation in the facility W. The method of acquiring the information on the position and the orientation of the moving body 10 is not limited to the method using the detection body, and, for example, simultaneous localization and mapping (SLAM) may be used.

[0039]

(Obstacle)

Here, since the reference path R0 is set to avoid a structure or the like installed in the facility W, the moving body 10 can move without interfering with the structure by moving along the reference path R0. However, the obstacle P may be temporarily located in the facility W, and, in a case where the obstacle P is present near the reference path R0, the moving body 10 may collide with the obstacle P, or the moving body 10 may stop to avoid the collision with the obstacle P. Therefore, in the present embodiment, the moving body 10 causes the sensor 26A to detect the obstacle P during

the movement, and switches the path to the avoidance path R2 for avoiding the obstacle P in a case where there is a possibility of interfering with the obstacle P. The details are described below. Here, the obstacle P may refer to any object, and may be a person.

[0040]

(Detection of Obstacle)

FIG. 6 is a schematic diagram showing an example of the detection of the obstacle. The detection control unit 84 of the moving body 10 causes the sensor 26A to detect the obstacle P located on a traveling direction (first direction) side of the moving body 10 while the moving body 10 is moving, and determines whether or not the obstacle P is present on the traveling direction side of the moving body 10 based on a detection result of the sensor 26A. In the present embodiment, the detection control unit 84 causes the sensor 26A to detect the traveling direction side of the moving body 10 at predetermined intervals while the moving body 10 is moving along the reference path R0, to detect whether or not the obstacle P is present. FIG. 6 shows an example in which the moving body 10 moves along the reference path R0 with a Y1 direction, which is one direction along the Y direction, as the traveling direction (first direction). The detection control unit 84 causes the sensor 26A to detect whether or not the obstacle P is present on the Y1 direction side of the moving body 10 when the moving body 10 is moving along the reference path R0 in the Y1 direction. FIG. 6 shows an example in which the obstacle P is detected on the Y1 direction side of the moving body 10 when the moving body 10 is located at the waypoint WP1 on the reference path R0. That is, in FIG. 6, the waypoint WP1 is the position of the moving body 10 when the obstacle P is detected.

[0041]

In a case where the obstacle P is detected on the Y1 direction side of the moving

body 10 by the sensor 26A, the detection control unit 84 may determine that the obstacle P is present. However, the detection control unit 84 is not limited thereto, and may determine whether or not the moving body 10 interferes with the obstacle P detected by the sensor 26A in a case where the moving body 10 continues moving as it is, based on the detection result of the sensor 26A, and determine that the obstacle P is present in a case where it is determined that the interference occurs. A method of determining the interference may be arbitrary. For example, the detection control unit 84 may identify a position of the obstacle P from the detection result of the sensor 26A and determine that the moving body 10 interferes with the obstacle P in a case where the position of the obstacle P is within a predetermined distance range from the reference path R0.

[0042]

(Stopping of Moving Body)

FIG. 7 is a schematic diagram showing an example of stopping of the moving body. In a case where the obstacle P is present on the traveling direction side of the moving body 10, the movement control unit 82 of the moving body 10 stops the moving body 10. That is, in a case where it is determined that the obstacle P is present, the movement control unit 82 starts control of stopping the moving body 10, to stop the moving body 10. As a result, the moving body 10 stops at a position on a side (second direction side) opposite to the traveling direction with respect to the obstacle P. In the example of FIG. 6, the obstacle P is detected (it is determined that the obstacle P is present) at the waypoint WP1 when the moving body 10 is moving along the reference path R0 in the Y1 direction, and thus the movement control unit 82 starts the control of stopping the moving body 10 in a case where the moving body 10 is located at the waypoint WP1. Therefore, as shown in the example of FIG. 7, the moving body 10 stops at a waypoint WP2 that is a position on the reference path R0 on the Y1 direction

side with respect to the waypoint WP1 and on a Y2 direction side (second direction side) with respect to the obstacle P.

[0043]

(Setting of Reverse Path)

FIG. 8 is a schematic diagram showing an example of the reverse path. In a case where the obstacle P is present on the traveling direction side of the moving body 10, the reverse path acquisition unit 86 of the moving body 10 acquires the reverse path R1. The reverse path R1 is a path that returns to the second direction (Y2 direction) opposite to the traveling direction (Y1 direction). More specifically, the reverse path R1 is a path from a position at which the moving body 10 is stopped (position on the Y2 direction side with respect to the obstacle P) to the Y2 direction.

[0044]

In the present embodiment, the reverse path acquisition unit 86 sets the reverse path R1 based on the reference path R0. Specifically, the reverse path acquisition unit 86 sets a predetermined position on the Y2 direction side (side away from the obstacle P) with respect to the position at which the moving body 10 is stopped, as a reverse position. The reverse path acquisition unit 86 sets a path from the position at which the moving body 10 is stopped to the reverse position based on the reference path R0, as the reverse path R1. While the reverse position may be set arbitrarily, in the present embodiment, the reverse path acquisition unit 86 may set the reverse position based on the position of the moving body 10 when the obstacle P is detected. For example, the reverse path acquisition unit 86 may set a position within a predetermined distance range from the position of the moving body 10 when the obstacle P is detected, as the reverse position.

[0045]

A method of setting the reverse path R1 based on the reference path R0 may be arbitrary. For example, the reverse path acquisition unit 86 may set a path extending toward the Y2 direction along the reference path R0, as the reverse path R1. That is, in this case, the reverse path R1 is along the reference path R0, whereas the traveling direction is opposite to the direction of the reference path R0. In the present example, the reverse path acquisition unit 86 sets the waypoint WP closest to the position of the moving body 10 when the obstacle P is detected, among the waypoints WP on the reference path R0, as the reverse position. Then, the reverse path acquisition unit 86 sets a path along the reference path R0 from the position at which the moving body 10 is stopped to the reverse position, as the reverse path R1. In the example of FIG. 8, the reverse path acquisition unit 86 sets a path along the reference path R0 from the waypoint WP2 that is the position at which the moving body 10 is stopped to the waypoint WP1 closest to the position at which the moving body 10 is stopped, as the reverse path R1.

[0046]

In addition, the moving body 10 moves along the reference path R0, but actually may move away from the reference path R0 due to a detection error of a self-position or the like. Therefore, for example, the reverse path acquisition unit 86 may set a path extending toward the Y2 direction along an actual movement trajectory of the moving body 10, as the reverse path R1. The movement trajectory refers to a path (trajectory) on which the moving body 10 actually moves when moving along the reference path R0. That is, in this case, the reverse path R1 is along the movement trajectory, whereas the traveling direction is in a direction opposite to the movement trajectory. When the moving body 10 moves along the movement trajectory, the reverse path acquisition unit 86 acquires time-series positions of the moving body 10 that moves along the reference

path R0, connects the positions, and sets a path extending toward the Y2 direction as the reverse path R1. More specifically, the reverse path acquisition unit 86 sets a path along the movement trajectory from the position at which the moving body 10 is stopped to the reverse position by designating the position of the moving body 10 when the obstacle P is detected as the reverse position, as the reverse path R1. Since the movement trajectory is a trajectory of the moving body 10 when moving along the reference path R0, it can be said that, in the present example as well, the reverse path acquisition unit 86 sets the reverse path R1 based on the reference path R0.

[0047]

A timing of setting the reverse path R1 may be arbitrary, and the reverse path R1 may be set after the moving body 10 is stopped. Further, for example, the reverse path R1 may be set after the obstacle P is detected and before the moving body 10 is stopped. In this case, the position at which the moving body 10 is stopped may be estimated based on the speed of the moving body 10 or the like, and the reverse path R1 may be set from the estimated position.

[0048]

In addition, in the above description, the reverse path acquisition unit 86 of the moving body 10 sets the reverse path R1, but the reverse path R1 may be set by any entity. For example, the information processing device 14 may set the reverse path R1 by the same method as in the above description based on the reference path R0, and the reverse path acquisition unit 86 of the moving body 10 may acquire the reverse path R1 from the information processing device 14.

[0049]

(Movement along Reverse Path)

The movement control unit 82 of the moving body 10 moves the moving body

10 along the reverse path R1. That is, the movement control unit 82 moves the moving body 10 from the position (waypoint WP2 in the example of FIG. 8) at which the moving body 10 is stopped to the reverse position (waypoint WP1 in the example of FIG. 8) in the Y2 direction along the reverse path R1.

[0050]

As described above, in the present embodiment, in a case where the obstacle P is present, the moving body 10 is stopped and reversed, but the stopping and the reversing (movement along the reverse path R1) are not essential processing. That is, for example, in a case where the obstacle P is present, the movement may be continued by switching the path to the avoidance path R2 (described later) without stopping and reversing. In addition, for example, in a case where the obstacle P is present, the movement may be continued by switching the path to the avoidance path R2 without stopping and reversing (movement along the reverse path R1).

[0051]

(Setting of Avoidance Path)

FIG. 9 is a schematic diagram showing an example of the avoidance path. In a case where the obstacle P is present on the traveling direction side of the moving body 10, the avoidance path acquisition unit 88 of the moving body 10 acquires the avoidance path R2. The avoidance path R2 is a path extending toward the Y1 direction while avoiding the obstacle P. In the present embodiment, the avoidance path acquisition unit 88 sets a path extending toward the Y1 direction with respect to the obstacle P without interfering with the obstacle P, based on the position of the obstacle P, as the avoidance path R2. A method of setting the avoidance path R2 may be arbitrary, but, for example, the avoidance path R2 may be set by performing optimization calculation with a constraint condition that the interference with the obstacle P does not occur.

More specifically, it is preferable that the avoidance path acquisition unit 88 sets a path that extends toward the Y1 direction while avoiding the obstacle P and that merges into the reference path R0 on the Y1 direction side with respect to the obstacle P, as the avoidance path R2.

[0052]

In the present embodiment, the moving body 10 reverses to the reverse position along the reverse path R1, and then moves along the avoidance path R2. Therefore, the avoidance path acquisition unit 88 sets the reverse position as a starting point of the avoidance path R2, and sets a path extending from the reverse position toward the Y1 direction while avoiding the obstacle P, as the avoidance path R2. In the example of FIG. 9, the avoidance path R2 expands in the X direction toward the Y1 direction from the reverse position to a position at which the obstacle P is present, and returns to the side opposite to the X direction toward the Y1 direction on the Y1 direction side with respect to the obstacle P to merge into the reference path R0. However, in a case where the moving body 10 is not reversed along the reverse path R1, the avoidance path acquisition unit 88 may set any position as the starting point of the avoidance path R2. For example, in a case where the moving body 10 is stopped but is not reversed along the reverse path R1, the position at which the moving body 10 is stopped may be set as the starting point of the avoidance path R2. In addition, for example, in a case where the moving body 10 is not stopped and reversed, a position between the position of the moving body 10 when the obstacle P is detected and the position of the obstacle P may be set as the starting point of the avoidance path R2.

[0053]

A timing of setting the avoidance path R2 may be arbitrary, and may be after the obstacle P is detected. For example, the avoidance path R2 may be set after the

moving body 10 arrives at the reverse position.

[0054]

In addition, in the above description, the avoidance path acquisition unit 88 of the moving body 10 sets the avoidance path R2, but the avoidance path R2 may be set by any entity. For example, the information processing device 14 may set the avoidance path R2 by the same method as in the above description based on the position of the obstacle P, and the avoidance path acquisition unit 88 of the moving body 10 may acquire the avoidance path R2 from the information processing device 14.

[0055]

(Movement along Avoidance Path)

In a case where the movement control unit 82 moves the moving body 10 to the reverse position along the reverse path R1, the movement control unit 82 moves the moving body 10 along the avoidance path R2. As a result, the moving body 10 can continue to move to the Y1 direction side while appropriately avoiding the obstacle P. In a case where the moving body 10 is stopped but is not reversed along the reverse path R1, the movement control unit 82 moves the moving body 10 from the position at which the moving body 10 is stopped along the avoidance path R2. In addition, for example, in a case where the moving body 10 is not stopped and reversed, the movement control unit 82 switches the path of the moving body 10 that is moving along the reference path R0 to the avoidance path R2, and moves the moving body 10 along the avoidance path R2. In a case where the avoidance of the obstacle P is completed by moving along the avoidance path R2, the movement control unit 82 may cause the moving body 10 to return to the reference path R0 and continue the movement along the reference path R0.

[0056]

(Updated Avoidance Path)

The avoidance path acquisition unit 88 sets the updated avoidance path based on the detection result of the sensor 26A when the moving body 10 is moving along the avoidance path R2. That is, the updated avoidance path refers to the avoidance path R2 different from the currently used avoidance path R2, and can be said to be the avoidance path R2 set based on the latest detection result of the sensor 26A.

[0057]

More specifically, when the moving body 10 is moving along the avoidance path R2, the detection control unit 84 continues the detection of the obstacle P by the sensor 26A. The avoidance path acquisition unit 88 determines whether or not the updated avoidance path needs to be set based on the detection result (latest detection result of the sensor 26A) of the sensor 26A during the movement along the avoidance path R2. For example, the avoidance path acquisition unit 88 may determine that the updated avoidance path needs to be set in a case where the interference with the obstacle P at the position calculated from the latest detection result of the sensor 26A occurs when the movement along the avoidance path R2 currently used is continued, and determine that the updated avoidance path does not need to be set in a case where the interference with the obstacle P does not occur.

[0058]

In a case where the updated avoidance path needs to be set, the avoidance path acquisition unit 88 sets a path extending toward the Y1 direction while avoiding the obstacle P at the position calculated from the latest detection result of the sensor 26A, as the updated avoidance path. A method of setting the updated avoidance path may be the same as the method of setting the avoidance path R2. In a case where the updated avoidance path is set, the movement control unit 82 switches (updates) the currently used avoidance path R2 to a newly set updated avoidance path, and moves the

moving body 10 along the avoidance path R2 by setting the newly set updated avoidance path as the avoidance path R2. The setting of the updated avoidance path and the switching to the updated avoidance path may be performed a plurality of times. That is, for example, the avoidance path acquisition unit 88 may further set the updated avoidance path based on the detection result of the sensor 26A while the moving body 10 is moving along the switched avoidance path R2, and switch the avoidance path R2 to the updated avoidance path. In a case where it is determined that the updated avoidance path does not need to be set, the movement along the set avoidance path R2 is continued.

[0059]

As the moving body 10 travels in the Y1 direction, the sensor 26A approaches the detected obstacle P or another obstacle P located in the Y1 direction, so that the obstacle P can be detected with higher accuracy. Therefore, it may be found that the obstacle P at the position calculated from the latest detection result of the sensor 26A cannot be avoided on the avoidance path R2 used so far. In such a case, the updated avoidance path is set using the latest detection result of the sensor 26A, and the path is switched to the updated avoidance path, so that the obstacle P can be more appropriately avoided.

[0060]

In addition, the updated avoidance path may be set by any entity, and, for example, the information processing device 14 may set the updated avoidance path by the same method as in the above description based on the position of the obstacle P, and the avoidance path acquisition unit 88 of the moving body 10 may acquire the updated avoidance path from the information processing device 14.

[0061]

(Setting of Updated Avoidance Path Satisfying Predetermined Condition)

FIGS. 10 to 12 are schematic diagrams showing examples of a case where the updated avoidance path cannot be set. In the present embodiment, the avoidance path acquisition unit 88 determines whether or not the updated avoidance path satisfying a predetermined condition can be set. The updated avoidance path satisfying the predetermined condition refers to a path that can avoid the obstacle P detected by the sensor 26A.

[0062]

In a case where the updated avoidance path satisfying the predetermined condition can be set, as described above, the avoidance path acquisition unit 88 sets the updated avoidance path, and the movement control unit 82 switches (updates) the currently used avoidance path R2 to the newly set updated avoidance path, and moves the moving body 10 along the avoidance path R2 by setting the newly set updated avoidance path as the avoidance path R2. On the other hand, in a case where the updated avoidance path satisfying the predetermined condition cannot be set, the avoidance path acquisition unit 88 sets a retract path R3 (described later) toward the Y2 direction, and the movement control unit 82 reverses the moving body 10 to the Y2 direction side along the retract path R3. That is, in a case where the updated avoidance path satisfying the predetermined condition cannot be set, the movement control unit 82 reverses the moving body 10 to the Y2 direction side by canceling the movement along the avoidance path R2. Details of the processing of reversing the moving body 10 to the Y2 direction side will be described later.

[0063]

More specifically, the updated avoidance path satisfying the predetermined condition refers to a path extending toward the Y1 direction while avoiding the obstacle

P at the position calculated from the latest detection result of the sensor 26A. That is, the updated avoidance path satisfying the predetermined condition can be set in a case where a path extending toward the Y1 direction while avoiding the obstacle P at the position calculated from the latest detection result of the sensor 26A can be set, and the updated avoidance path satisfying the predetermined condition cannot be set in a case where such a path cannot be set. For example, FIG. 10 shows a case where the obstacle P (obstacle PA in FIG. 10) that is not initially detected is detected when the moving body 10 is moving along the avoidance path R2. In this case, depending on the position of the obstacle PA, in a case where the movement is further performed in the Y1 direction, the movement may interfere with any of the obstacles P and PA, and a path that avoids both the obstacles P and PA may not be set. In such a case, the updated avoidance path satisfying the predetermined condition (extending toward the Y1 direction while avoiding the obstacle) cannot be set. In addition, as shown in the example of FIG. 11, there are cases where, when the moving body 10 is moving along the avoidance path R2, the position and the orientation of the detected obstacle P are detected with higher accuracy, and the movement is further performed in the Y1 direction, the movement interferes with the detected obstacle P, and a path that avoids the obstacle P cannot be set. In such a case as well, the updated avoidance path satisfying the predetermined condition (extending toward the Y1 direction while avoiding the obstacle) cannot be set.

[0064]

In addition, the updated avoidance path satisfying the predetermined condition more preferably refers to a path that extends toward the Y1 direction while avoiding the obstacle P at the position calculated from the latest detection result of the sensor 26A and that merges into the reference path R0 on the Y1 direction side with respect to the obstacle P. That is, in this case, the updated avoidance path satisfying the

predetermined condition can be set in a case where a path that avoids the obstacle P at the position calculated from the latest detection result of the sensor 26A and that merges into the reference path R0 on the Y1 direction side with respect to the obstacle P can be set, and the updated avoidance path satisfying the predetermined condition cannot be set in a case where such a path cannot be set (for example, in a case where only a path that can avoid the obstacle P but that cannot merge into the reference path R0 can be set). For example, in FIG. 12, the reference path R0 is a trajectory that curves to the side opposite to the X direction immediately on the Y1 direction side of the obstacle P. In this case, in a case where the movement is further performed in the Y1 direction, the obstacle P can be avoided, but the movement may interfere with a wall W on the Y1 direction side, and the movement may not converge to the reference path R0 that bends to the side opposite to the X direction. In such a case, it can be said that the updated avoidance path satisfying the predetermined condition (merging with the reference path R0 while avoiding the obstacle P) cannot be set.

[0065]

In addition, for example, during a period when the moving body 10 is moving along the reference path R0, a surrounding region including the reference path R0 along which the moving body 10 moves may be set as a prohibited region. The prohibited region is a region into which only the moving body 10 can enter and into which another moving body is prohibited from entering. In this case, the updated avoidance path satisfying the predetermined condition can be set in a case where a path extending toward the Y1 direction while avoiding the obstacle P at the position calculated from the latest detection result of the sensor 26A can be set without extending outside the prohibited region, and the updated avoidance path satisfying the predetermined condition may not be set in a case where such a path cannot be set (for example, in a

case where only a path that can avoid the obstacle P but that extends outside the prohibited region can be set).

[0066]

(Setting of Retract Path)

FIG. 13 is a schematic diagram showing an example of the retract path. As described above, in a case where the updated avoidance path satisfying the predetermined condition cannot be set, the avoidance path acquisition unit 88 sets the retract path R3. The retract path R3 is a path that returns to the second direction (Y2 direction). More specifically, the retract path R3 is a path extending from the current position (for example, the position of the moving body 10 in a case where the determination result that the updated avoidance path cannot be set is acquired) of the moving body 10 that is moving along the avoidance path R2 toward the Y2 direction.

[0067]

In the present embodiment, the avoidance path acquisition unit 88 sets a predetermined position on the Y2 direction side with respect to the current position of the moving body 10, as a retract position. The avoidance path acquisition unit 88 sets a path from the current position of the moving body 10 toward the retract position, as the retract path R3. While the retract position may be arbitrarily set, in the present embodiment, the starting point of the avoidance path R2 set first may be set as the retract position. In the example of FIG. 13, a path extending from the current position of the moving body 10 to the waypoint WP1 that is the starting point of the avoidance path R2 is set as the retract path R3.

[0068]

A method of setting the retract path R3 may be arbitrary. For example, the avoidance path acquisition unit 88 may set the retract path R3 based on the detection

result of the sensor 26A. In this case, the avoidance path acquisition unit 88 may set a path extending toward the retract position while avoiding the obstacle P detected by the sensor 26A, as the retract path R3. For example, the avoidance path acquisition unit 88 sets a path extending toward the retract position while avoiding the obstacle P based on the latest detection result of the sensor 26A, as the retract path R3. A method of setting the retract path R3 in this case may be the same as the method of setting the avoidance path R2. The moving body 10 may continue the detection by the sensor 26A even during the movement along the retract path R3, and update the retract path R3 based on the detection result of the sensor 26A during the movement along the retract path R3.

[0069]

Further, for example, the avoidance path acquisition unit 88 may set the retract path R3 based on the avoidance path R2. In this case, for example, the avoidance path acquisition unit 88 may set a path extending toward the opposite direction along the avoidance path R2, as the retract path R3. More specifically, the avoidance path acquisition unit 88 may set a path that merges into the avoidance path R2 set first and that extends toward the retract position, as the retract path R3.

[0070]

The moving body 10 moves while performing the detection by the sensor 26A. In a case where the detection result of the sensor 26A indicates that the obstacle is present in a safety region set on the front direction side (side on which the forks 24 are not provided) and the rear direction side (side on which the forks 24 are provided) of the moving body 10, the movement control unit 82 stops the movement of the moving body 10. The safety region may be arbitrarily set, but may be set to have different sizes depending on the orientation of the moving body 10 with respect to the traveling

direction. For example, the safety region on the traveling direction side of the moving body 10 is set to be wider than the safety region on the side opposite to the traveling direction of the moving body 10. That is, in this case, the safety region in the front direction when the moving body 10 moves forward (moves toward the traveling direction side in the front direction) is set to be wider than the safety region in the rear direction when the moving body 10 moves forward. Similarly, the safety region in the rear direction when the moving body 10 reverses (moves toward the traveling direction side in the rear direction) is set to be wider than the safety region in the front direction when the moving body 10 reverses. In a case where the safety region has different sizes and the retract path R3 is set based on the avoidance path R2, when the moving body 10 retracts along the retract path R3, the obstacle P may be located in the safety region, and the moving body 10 may not be able to return to the retract position. That is, for example, in a case where the moving body 10 moves on the front direction side as the traveling direction (in a case of moving forward) along the avoidance path R2, the safety region on the rear direction side is narrowed, and thus the moving body 10 can continue the movement as long as the obstacle P is outside the narrow safety region on the rear direction side even in a case where the obstacle P is located on the side opposite to the traveling direction (rear direction side). However, in a case where the moving body 10 reverses by moving along the retract path R3 along the avoidance path R2 with the rear direction side as the traveling direction, the obstacle P is located on the traveling direction side (rear direction side) on which the safety region is wide. Therefore, there is a risk that the obstacle P enters the wide safety region on the traveling direction side, which causes the moving body 10 to stop while moving along the retract path R3. In view of such a case, it is preferable that the avoidance path acquisition unit 88 sets the avoidance path R2 such that the obstacle P is not located in the wider safety

region in both the front direction and the rear direction. As a result, it is possible to prevent the moving body 10 from stopping when the moving body 10 is moving along the retract path R3.

[0071]

(Movement along Retract Path)

The movement control unit 82 of the moving body 10 moves the moving body 10 along the retract path R3. That is, the movement control unit 82 switches the path from the avoidance path R2 to the retract path R3, and reverses to the retract position (waypoint WP1 in the example of FIG. 13) along the retract path R3.

[0072]

(Update of Reference Path)

FIG. 14 is a schematic diagram showing an example of an update of the reference path. In a case where the moving body 10 moves to the retract position along the retract path R3, the reference path R0 is updated to pass through a position at which the obstacle P is not present. That is, in this case, the moving body 10 transmits the position information of the obstacle P to the information processing device 14. The reference path setting unit 60 of the information processing device 14 sets a new reference path R0 that passes through a position at which the obstacle P is not present, based on the position information of the obstacle P. For example, the reference path setting unit 60 sets a path extending from the current position (retract position) of the moving body 10 toward the movement destination of the moving body 10, without passing through the waypoint WP within the predetermined distance range from the position of the obstacle P, as the new reference path R0. The reference path setting unit 60 transmits the newly set reference path R0 to the moving body 10. The movement control unit 82 of the moving body 10 moves the moving body 10 along the

newly set reference path R0. In the example of FIG. 14, the original reference path R0 is a path that passes through the waypoint within the predetermined distance range from the obstacle P and that extends toward the waypoint WP4 that is an end point (movement destination). Therefore, in the example of FIG. 14, a detour path extending from the waypoint WP0 toward the waypoint WP4 without passing through the waypoint within the predetermined distance range from the obstacle P is set as a new reference path R0a. By setting the new reference path R0 in this way, it is possible to appropriately head toward the original movement destination even in a case where the avoidance path R2 (updated avoidance path) that avoids the obstacle P or returns to the original reference path R0 cannot be set.

[0073]

However, updating the reference path R0 is not limited to a case where the movement is performed to the retract position. For example, even in a case where the updated avoidance path that avoids the obstacle P or returns to the reference path R0 cannot be set from a position reached after proceeding to some extent along the avoidance path R2, the avoidance path R2 that avoids the obstacle P or returns to the reference path R0 may be set from the retract position that is further back than the position. Therefore, when the moving body 10 moves to the retract position along the retract path R3, the avoidance path acquisition unit 88 may determine whether or not the avoidance path R2 that extends toward the Y1 direction from the retract position while avoiding the obstacle P can be set based on the position of the obstacle P based on the detection results of the sensor 26A so far. In a case where such an avoidance path R2 can be set, the avoidance path acquisition unit 88 may set the avoidance path R2, and the movement control unit 82 may move the moving body 10 along the avoidance path R2. In a case where the avoidance path R2 cannot be set, the reference path R0 may

be updated as described above.

[0074]

(Processing Flow)

A control flow of the moving body described above will be described. FIG. 15 is a flowchart showing the control flow of the moving body. As shown in FIG. 15, while the moving body 10 is moving along the reference path R0, the detection control unit 84 causes the sensor 26A to detect the obstacle P (step S10). The detection control unit 84 acquires the detection result of the sensor 26A, and determines whether or not the obstacle P is present on the traveling direction side of the moving body 10 (step S12), and when the obstacle P is not present (step S12; No), the processing returns to step S10, and the movement along the reference path R0 is continued. On the other hand, when the obstacle P is present (step S12; Yes), the moving body 10 sets the avoidance path R2 by the avoidance path acquisition unit 88 (step S14), and moves along the avoidance path R2 by the movement control unit 82 (step S16). In a case where the obstacle P is present, the moving body 10 may be stopped, the moving body 10 may be reversed along the reverse path R1, and then the path may be switched to the avoidance path R2.

[0075]

Even when moving body 10 is moving along the avoidance path R2, the detection control unit 84 causes the sensor 26A to detect the obstacle P, and determines whether or not the updated avoidance path needs to be set based on the detection result of the sensor 26A (step S18). When the updated avoidance path does not need to be set (step S18; No), the movement along the avoidance path R2 is continued. On the other hand, when the updated avoidance path needs to be set (step S18; Yes), the moving body 10 attempts to set the updated avoidance path satisfying the predetermined condition based on the detection result of the sensor 26A by the avoidance path

acquisition unit 88, and when the updated avoidance path can be set (step S20; Yes), the moving body 10 switches from the avoidance path R2 to the updated avoidance path (step S22), and moves along the updated avoidance path. On the other hand, when the updated avoidance path cannot be set (step S20; No), the moving body 10 sets the retract path R3 by the avoidance path acquisition unit 88, and reverses along the retract path R3 by the movement control unit 82 (step S24).

[0076]

(Effects)

As described above, in the present embodiment, when the obstacle P is detected, the movement is continued by switching to the avoidance path R2. However, due to the detection accuracy of the sensor 26A or the like, the obstacle P may not be appropriately avoided even when the movement is performed along the avoidance path R2. On the other hand, in the present embodiment, after switching to the avoidance path R2, it is determined whether or not the updated avoidance path can be set, and in a case where the updated avoidance path cannot be set, the moving body 10 is reversed. As a result, in a case where the obstacle P cannot be avoided on the avoidance path R2, the moving body 10 can be returned, so that the obstacle P can be appropriately avoided. Furthermore, after the moving body 10 is reversed, the reference path R0 or the avoidance path R2 is updated, so that the movement can be continued while avoiding the obstacle P.

[0077]

(Second Embodiment)

Next, a second embodiment will be described. The second embodiment is different from the first embodiment in that the avoidance path R2 is set based on subgoals. In the second embodiment, description is omitted for portions whose

configuration is common with the first embodiment.

[0078]

(Setting of Subgoals)

In the second embodiment, in a case where it is determined that the obstacle P is present, the avoidance path acquisition unit 88 sets subgoals S based on the detection result of the sensor 26A. The subgoal S is a position (coordinates) assumed not to interfere with the obstacle P. The avoidance path acquisition unit 88 sets a plurality of subgoals S having different positions. The avoidance path acquisition unit 88 may set the subgoal S by any method based on the detection result of the sensor 26A, but, for example, sets a position different from the position of the obstacle P detected by the sensor 26A as the subgoal S. Hereinafter, a setting example of the subgoal S will be described.

[0079]

FIGS. 16 to 18 are schematic diagrams showing examples of a method of setting the subgoals. For example, as shown in FIG. 16, the avoidance path acquisition unit 88 may set, as the subgoal S, each position that is spaced by a distance ΔL in a cross direction (in the example of FIG. 16, X direction) crossing the traveling direction (Y1 direction in the example of FIG. 16) of the reference path R0 from each position on the reference path R0. However, in this case, among the positions on the reference path R0, at the position within a predetermined distance range from the position of the obstacle P detected by the sensor 26A, a position spaced by the distance ΔL from the position of the obstacle P detected by the sensor 26A is set as the subgoal S without setting a position spaced by the distance ΔL from a position on the reference path R0 as the subgoal S. That is, in the example of FIG. 6, the avoidance path acquisition unit 88 sets, as the subgoal S, each position spaced by the distance ΔL from each position on

the reference path R0 outside the predetermined distance range from the position of the obstacle P in the cross direction and a position spaced by the distance ΔL from the position of the obstacle P in the cross direction. The distance ΔL may be arbitrarily set and is preferably a constant length for each position, but is not limited thereto, and may be a different length for each position.

[0080]

In addition, for example, as shown in FIG. 17, the avoidance path acquisition unit 88 may set, as the subgoal S, a set of positions (preferably, midpoint positions) between the obstacle detected by the sensor 26A in the cross direction (X direction in the example of FIG. 17) crossing the traveling direction (Y1 direction in the example of FIG. 17) of the reference path R0. In the example of FIG. 17, the obstacle P is detected on the traveling direction side of the reference path R0, and the walls W as obstacles are detected on both sides in the cross direction. In this case, in a section where the obstacle P is not present and the walls W are present on both sides among sections toward the traveling direction side of the reference path R0, the avoidance path acquisition unit 88 sets each position (each midpoint position in the present example) between the walls W on both sides on the cross direction side as the subgoal S. In addition, in a section where the obstacle P is present among the sections toward the traveling direction side of the reference path R0, the avoidance path acquisition unit 88 sets each position (each midpoint position in the present example) between the walls W and the obstacle P in the cross direction as the subgoal S.

[0081]

In addition, for example, as shown in FIG. 18, in a case where it is determined that the obstacle P moves, the avoidance path acquisition unit 88 may set an obstacle region ARP1 in which the obstacle P may be present due to its movement. In this case,

the avoidance path acquisition unit 88 may set the positions arranged toward the traveling direction of the reference path R0, which are positions outside the obstacle region ARP1, as the subgoals S. A method of determining that the obstacle P moves may be arbitrary, and, for example, the avoidance path acquisition unit 88 may identify a shape of the obstacle P from the detection result of the sensor 26A, and determine that the obstacle P moves in a case where the shape satisfies a predetermined condition. In addition, the avoidance path acquisition unit 88 may treat all the detected obstacles P as moving bodies without determining whether or not the detected obstacles P will move. The avoidance path acquisition unit 88 may set the obstacle region ARP1 by any method based on the position of the obstacle P detected by the sensor 26A. For example, the avoidance path acquisition unit 88 may set a region having, as an outer periphery, positions that are a predetermined distance away from the position of the obstacle P detected by the sensor 26A, as the obstacle region ARP1.

[0082]

(Setting of Basis Path)

FIG. 19 is a schematic diagram showing an example of setting a basis path. The avoidance path acquisition unit 88 sets a basis path R2a based on the subgoals S set by the avoidance path acquisition unit 88. The basis path R2a refers to a path used for setting the avoidance path R2. The avoidance path acquisition unit 88 sets a path passing through a position within a predetermined distance range from the subgoals S, as the basis path R2a. In the present embodiment, since the plurality of subgoals S are set, it can be said that the avoidance path acquisition unit 88 sets a path passing through each position within a predetermined distance range from each subgoal S, as the basis path R2a. In the example of FIG. 19, the basis path R2a passes over each subgoal S, but the basis path R2a is not limited thereto, and may be a path passing through a position

that is a predetermined distance away from each subgoal S.

[0083]

The avoidance path acquisition unit 88 may set the basis path R2a by any method based on the subgoals S, but, in the present embodiment, the basis path R2a is set by using a method having a lower calculation load than a calculation load in setting the avoidance path R2 described later. More specifically, the avoidance path acquisition unit 88 sets the basis path R2a based on the subgoals S and motion characteristics of the moving body 10. Here, the motion characteristics may be regarded as a constraint condition based on the motion characteristics of the moving body 10. That is, it can be said that the avoidance path acquisition unit 88 sets a path passing through the positions within a predetermined distance range from the subgoals S while satisfying the constraint condition based on the motion characteristics of the moving body 10, as the basis path R2a. The motion characteristics of the moving body 10 refer to, for example, a minimum turn radius, an upper limit speed, and the like of the moving body 10.

[0084]

In the present embodiment, it is preferable that the avoidance path acquisition unit 88 sets the basis path R2a without using the position information of the obstacle P identified from the detection result of the sensor 26A. That is, it is preferable that the avoidance path acquisition unit 88 sets the basis path R2a without using the constraint condition that the interference with the obstacle P identified from the detection result of the sensor 26A does not occur. By not applying the constraint condition that the interference with the obstacle P does not occur, the calculation load can be reduced, and the basis path R2a can be calculated in a shorter calculation time.

[0085]

For example, the avoidance path acquisition unit 88 may set the basis path R2a by using the Pure Pursuit method or the Dynamic Window Approach.

[0086]

(Setting of Avoidance Path)

FIG. 20 is a schematic diagram showing an example of setting the avoidance path. The avoidance path acquisition unit 88 sets the avoidance path R2 that can avoid the obstacle P based on the basis path R2a and the detection result of the sensor 26A acquired by the detection control unit 84. That is, the avoidance path acquisition unit 88 sets the avoidance path R2 that does not interfere with the obstacle P detected by the sensor 26A, based on information on the basis path R2a and the position information of the obstacle P detected by the sensor 26A. Here, the avoidance path R2 can be calculated from only the position information of the obstacle P, but, in the present embodiment, since the avoidance path R2 can be calculated based also on the basis path R2a by using the information on the basis path R2a, an appropriate avoidance path R2 can be set while reducing the calculation time.

[0087]

In the present embodiment, the avoidance path acquisition unit 88 sets the avoidance path R2 by performing optimization calculation with the constraint condition that the interference with the obstacle P does not occur, using the basis path R2a as an initial solution. Furthermore, it is preferable that the avoidance path acquisition unit 88 sets the avoidance path R2 by performing optimization calculation such that the basis path R2a is used as an initial solution and the constraint condition that interference with the obstacle P does not occur and the constraint condition based on the motion characteristics of the moving body 10 are satisfied. That is, the avoidance path acquisition unit 88 sets the avoidance path R2 by performing optimization calculation

using the basis path R2a as an initial solution, with the constraint condition that the moving body 10 is not located within a predetermined distance range from the position of the obstacle P identified from the detection result of the sensor 26A and the constraint condition that the motion characteristics of the moving body 10 are satisfied. Accordingly, it is possible to set an appropriate avoidance path R2 that does not interfere with the obstacle P while satisfying the motion characteristics of the moving body 10, while shortening the calculation time. Here, the initial solution is a base solution in the optimization calculation. That is, by searching for an optimal solution from the basis path R2a which is the initial solution, convergence to the optimal solution can be accelerated, enabling an appropriate avoidance path R2 to be set while shortening calculation time.

[0088]

For example, the avoidance path acquisition unit 88 may set the avoidance path R2 using methods such as a primal-dual interior-point method or sequential quadratic programming.

[0089]

(Modification Example 1 of Second Embodiment)

Next, a modification example 1 of the second embodiment will be described. The present example is different from the second embodiment in that a region AR1 surrounded by a point cloud M, which is the detection result of the sensor 26A, is set as a non-interference region, and the subgoals S or the avoidance path R2 is set. In the present example, description is omitted for portions whose configuration is common with the second embodiment.

[0090]

FIGS. 21 and 22 are schematic diagrams showing setting of the non-interference

region. In the present example, the detection control unit 84 causes the sensor 26A to emit the laser light. The detection control unit 84 acquires the point cloud M based on the detection result of the reflected light received by the sensor 26A. That is, the point cloud M can be said to be measurement points indicating positions at which the laser light is applied (positions at which the laser light is reflected). In the present embodiment, the sensor 26A receives the reflected light from different positions around the moving body 10 because the sensor 26A emits the laser light while scanning in the lateral direction (horizontal direction orthogonal to the Z direction). Therefore, it can be said that the detection control unit 84 acquires a plurality of point clouds M indicating the obstacles around the moving body 10 by one scanning with the laser light. That is, as shown in FIG. 21, a line connecting a position of the sensor 26A to the point cloud M is referred to as a line L1, a virtual line passing through the sensor 26A and having a fixed direction relative to the moving body 10 is referred to as a line L2, and a deviation amount in an angle of the line L1 with respect to the line L2 is referred to as an azimuth angle θ between the sensor 26A and the point cloud M. In this case, it can be said that the detection control unit 84 acquires the plurality of point clouds M having different values of the azimuth angle θ. In the example of FIG. 21, two obstacles P are present on the traveling direction side of the reference path R0 with respect to the moving body 10, and the walls W are present on both sides of the reference path R0 in the traveling direction. Therefore, in the example of FIG. 21, the detection control unit 84 acquires the point clouds M indicating the positions of the walls W on both sides and the point clouds M indicating the positions of the obstacles P.

[0091]

As shown in FIG. 22, the detection control unit 84 calculates a line L3 connecting each point cloud M in an order of a magnitude of the azimuth angle θ from

the position of the sensor 26A. That is, the line L3 includes a line connecting the position of the sensor 26A to a point cloud M1 at which the azimuth angle θ is smallest (in the example of FIG. 22, the azimuth angle θ is most negative), a line connecting each point cloud M in ascending order of the azimuth angle θ, and a line connecting the position of the sensor 26A to a point cloud M2 at which the azimuth angle θ is largest (in the example of FIG. 22, the azimuth angle θ is most positive). The detection control unit 84 sets an inner side of the region AR1 surrounded by the line L3 calculated in this way as the non-interference region.

[0092]

In the present example, at least one of the subgoals S and the avoidance path R2 is set based on the non-interference region set in this way. For example, in a case where the subgoals S are set based on the non-interference region, the avoidance path acquisition unit 88 sets the subgoals S to be located in the non-interference region. In this case, the avoidance path acquisition unit 88 may set the positions located within the non-interference region and arranged toward the traveling direction of the moving body 10, as the subgoals S. In addition, for example, in a case where the avoidance path R2 is set based on the non-interference region, the avoidance path acquisition unit 88 sets the avoidance path R2 such that the moving body 10 is located within the non-interference region (is not located outside the non-interference region). That is, the avoidance path R2 may be set by treating a fact that the moving body 10 is located within the non-interference region as the constraint condition that the interference with the obstacle P does not occur, and performing optimization calculation using the basis path R2a as the initial solution and satisfying a constraint condition that the moving body 10 is located within the non-interference region and the constraint condition based on the motion characteristics of the moving body 10.

[0093]

By setting the non-interference region in this way and setting the subgoals S or the avoidance path R2, for example, calculation such as ray tracing is not required, and calculation time of the subgoals S or of the avoidance path R2 can be shortened. In addition, for example, even in a case where there are a plurality of obstacles P, the non-interference region that does not interfere with the obstacles P can be set, so that an appropriate path that can avoid the plurality of obstacles P can be set.

[0094]

FIG. 23 is a schematic diagram showing another example of the setting of the non-interference region. In the present embodiment, since the sensor 26A is caused to perform the detection at the predetermined intervals, the detection control unit 84 acquires a set of point clouds M acquired by one scanning for each detection of the sensor 26A (for each position of the moving body 10). In this case, for each of a plurality of sets of point clouds M acquired for each detection, the detection control unit 84 sets the region AR1 surrounded by the line L3 using the above-described method, based on one set of point clouds M. For example, in the example of FIG. 23, a region AR1a set from the point cloud M acquired by detection at a certain time and a region AR1b set from the point cloud M acquired by detection at another time are shown. The detection control unit 84 may set the non-interference region based on each set region AR1. A method of setting the non-interference region based on each of the regions AR1 may be arbitrary. For example, the detection control unit 84 divides an entire region (region AR) into a plurality of unit regions, and counts the number of times each unit region is located in the region AR1 for each region AR1. The detection control unit 84 may set a group of unit regions in which the number of times the unit region is located in the region AR1 is equal to or greater than a predetermined threshold value, as

the non-interference region.

[0095]

In this way, by setting the non-interference region based on the region AR1 for each detection of the sensor 26A, it is possible to set the non-interference region from the accumulated detection results, and it is possible to set the non-interference region that is assumed not to interfere with the obstacle P with higher accuracy.

[0096]

(Modification Example 2 of Second Embodiment)

Next, a modification example 2 of the second embodiment will be described. The present example is different from the second embodiment in that some point clouds M, which are the detection results of the sensor 26A, are thinned out, and remaining point clouds M are used as point clouds for analysis to set the subgoals S or the avoidance path R2. In the present example, description is omitted for portions whose configuration is common with the second embodiment. The present example can also be applied to the modification example 1 of the second embodiment.

[0097]

FIG. 24 is a schematic diagram showing an example of a method of extracting the point cloud for analysis. In the present example, the detection control unit 84 extracts the point cloud for analysis from among the acquired point clouds M based on a distance from the moving body 10 to the point clouds M. It is preferable that the detection control unit 84 extracts the point cloud M close to the moving body 10 (reference path R0) as the point cloud for analysis. Specifically, as shown in FIG. 24, the detection control unit 84 sets segmented regions ARD by dividing the region AR in which the moving body 10 is assumed to move into a plurality of regions. Although the segmented regions ARD may be arbitrarily set, the detection control unit 84 may set,

for example, as shown in FIG. 24, a plurality of segmented regions ARD by dividing a region on the traveling direction side of the reference path R0 from the position of the moving body 10 at each predetermined distance in the traveling direction of the reference path R0. The detection control unit 84 extracts, as a nearby point cloud Ma, the point cloud M closest to the moving body 10 (reference path R0) from among the point clouds M in the segmented regions ARD. The detection control unit 84 performs this processing for each segmented region ARD to extract the nearby point cloud Ma for each segmented region ARD. In the example of FIG. 24, for each of the segmented regions ARD, the detection control unit 84 extracts the point cloud M closest to the moving body 10 (reference path R0) among the plurality of point clouds M located on one side in the cross direction (X direction in the example of FIG. 24) with respect to the moving body 10 (reference path R0) and the point cloud M closest to the moving body 10 (reference path R0) among the plurality of point clouds M located on the other side in the cross direction with respect to the moving body 10 (reference path R0), as the nearby point clouds Ma of the segmented region ARD.

[0098]

The detection control unit 84 sets the extracted nearby point cloud Ma as the point cloud for analysis. In the present example, at least one of the subgoals S and the avoidance path R2 is set based on the point cloud for analysis set in this way. That is, in the present example, the point clouds M other than the point cloud M extracted as the point cloud for analysis are not used for calculation of at least one of the subgoals S and the avoidance path R2. For example, as in the second embodiment, the position of the obstacle P may be identified based on the point cloud for analysis, and the subgoals S or the avoidance path R2 may be set. In addition, for example, the non-interference region may be set based on the point cloud for analysis as in the modification example

1 of the second embodiment, and the subgoals S or the avoidance path R2 may be set. Some point clouds M acquired in this way are extracted as the point clouds for analysis and used for the subgoals S or the avoidance path R2, so that it is possible to reduce a dimensionality in calculation and to reduce the calculation time.

[0099]

Furthermore, the detection control unit 84 may extract positions (for example, center positions) between the adjacent nearby point clouds Ma as auxiliary point clouds Mb, and set the nearby point clouds Ma and the auxiliary point clouds Mb as the point clouds for analysis. In this case, for example, the detection control unit 84 may calculate a distance between the adjacent nearby point clouds Ma, and set the auxiliary point clouds Mb between the adjacent nearby point clouds Ma when the distance is equal to or greater than a predetermined threshold value. As described above, by setting the auxiliary point clouds Mb at the positions at which the nearby point clouds Ma are spaced from each other, it is possible to suppress a decrease in calculation accuracy while reducing the calculation time.

[0100]

(Third Embodiment)

Next, a third embodiment will be described. The third embodiment is different from the first embodiment in that the avoidance path R2A of another moving body 10A is set based on the avoidance path R2 of the moving body 10. In the third embodiment, description is omitted for portions whose configuration is common with the first embodiment. The third embodiment can also be applied to the second embodiment and the modification examples thereof.

[0101]

FIG. 25 is a schematic diagram showing the avoidance path of another moving

body. In the third embodiment, the moving body 10 (first moving body) for which the avoidance path R2 is set transmits information on the avoidance path R2 to the information processing device 14. A method of setting the avoidance path R2 of the moving body 10 is the same as the method described in the above-described embodiment or modification examples.

[0102]

In the third embodiment, as an example, a case will be described where a reference path R0A is set for the moving body 10A other than the moving body 10, and a scheduled time period for the moving body 10A to pass through the reference path R0A is set later than a scheduled time period for the moving body 10 to pass through the reference path R0. In this case, the information processing device 14 determines whether or not the reference path R0A of the moving body 10A satisfies a predetermined condition. Here, the predetermined condition refers to the fact that the reference path R0A passes through a position of the obstacle P detected by the moving body 10 within a predetermined distance range. Further, it is preferable that the predetermined condition refers to the fact that the reference path R0A overlaps the reference path R0 in the vicinity of the obstacle P detected by the moving body 10. For example, in this case, when the reference path R0A passes through, among the waypoints WP through which the reference path R0 passes, the waypoint WP (in the example of FIG. 25, the waypoint WP1) on the Y2 direction side with respect to the position of the obstacle P and within the predetermined distance range from the position of the obstacle P, and the waypoint WP (in the example of FIG. 25, the waypoint WP3) on the Y1 direction side with respect to the position of the obstacle P and within the predetermined distance range from the position of the obstacle P, the reference path R0A may overlap the reference path R0.

[0103]

In a case where the reference path R0A of the moving body 10A satisfies the predetermined condition, the information processing device 14 transmits the information on the avoidance path R2 of the moving body 10 to the moving body 10A. For example, the information processing device 14 may transmit the information on the avoidance path R2 of the moving body 10 itself to the moving body 10A. The avoidance path acquisition unit 88 of the moving body 10A sets the avoidance path R2A for avoiding the obstacle P based on the information on the avoidance path R2 of the moving body 10 acquired from the information processing device 14. The starting point of the avoidance path R2A may be the waypoint WP on the reference path R0A on the Y1 direction side with respect to the position of the obstacle P and within the predetermined distance range from the position of the obstacle P, and the end point of the avoidance path R2A may be the waypoint WP on the reference path R0A on the Y2 direction side with respect to the position of the obstacle P and within the predetermined distance range from the position of the obstacle P. For example, the avoidance path acquisition unit 88 of the moving body 10A may set a path overlapping the avoidance path R2 of the moving body 10 (in the example of FIG. 25, the avoidance path R2 extending from the waypoint WP1 to the waypoint WP3) as the avoidance path R2A.

[0104]

The movement control unit 82 of the moving body 10A moves the moving body 10A to the starting point (in the example of FIG. 25, the waypoint WP1) of the avoidance path R2A along the reference path R0A, and then switches the path to the avoidance path R2A to move the moving body 10A from the starting point to the end point (in the example of FIG. 25, the waypoint WP3) of the avoidance path R2A along the avoidance path R2A. Then, the moving body 10A returns to the reference path R0A to continue

the movement. That is, in this case, the moving body 10A avoids the obstacle P by using the avoidance path R2A without stopping and reversing in front of (on the Y2 direction side of) the obstacle P.

[0105]

As described above, in the third embodiment, information on the moving body 10 that has detected the obstacle P is shared with the moving body 10A that passes through the vicinity of the obstacle P later, and the moving body 10A can avoid the obstacle P without stopping and reversing. As a result, the moving body 10A can shorten the time for avoiding the obstacle P.

[0106]

In the above description, the moving body 10A sets the avoidance path R2A of the moving body 10A by using the information on the avoidance path R2 itself as the information on the avoidance path R2 of the moving body 10, but the present disclosure is not limited to this. For example, the moving body 10A may acquire information on the non-interference region (see the modification examples of the second embodiment) that is a region that does not interfere with the obstacle P, which is set by the moving body 10, as the information on the avoidance path R2 of the moving body 10. In this case, the avoidance path acquisition unit 88 of the moving body 10A may set the avoidance path R2A using the non-interference region set by the moving body 10 by the same method as in the modification examples of the second embodiment.

[0107]

In addition, in a case where the moving body 10 that has detected the obstacle P cannot avoid the obstacle P on the avoidance path R2, that is, for example, in a case where the reference path R0 is updated to pass through a position at which the obstacle P is not present after the moving body 10 returns to the retract position along the retract

path R3, the moving body 10A may not be able to avoid the obstacle P even using the avoidance path R2 of the moving body 10. Therefore, in such a case, the moving body 10 may transmit the position information of the detected obstacle P to the information processing device 14, and the moving body 10A may acquire the position information of the obstacle P from the information processing device 14 and set the avoidance path R2A based on the position information. In addition, for example, the moving body 10A may set the avoidance path R2A using the non-interference region set by the moving body 10 by the same method as in the modification examples of the second embodiment.

[0108]

(Effects)

A first aspect of the present disclosure relates to a control method of a moving body 10 that automatically moves, the control method including: a step of moving the moving body 10 along a reference path R0; a step of causing a sensor 26A provided on the moving body 10 to detect an obstacle P located on a side toward a Y1 direction (first direction) that is a traveling direction of the moving body 10 when the moving body 10 is moving along the reference path R0; a step of setting an avoidance path R2 that extends toward the Y1 direction while avoiding the obstacle P in a case where the obstacle P is present on the side toward the Y1 direction; a step of moving the moving body 10 along the avoidance path R2; a step of determining whether or not an updated avoidance path that is a different avoidance path R2 satisfying a predetermined condition is generatable when the moving body 10 is moving along the avoidance path R2; and a step of reversing the moving body 10 in a Y2 direction (second direction) opposite to the Y1 direction in a case where the updated avoidance path satisfying the predetermined condition is not generatable. According to the present disclosure, it is possible to appropriately avoid the obstacle P.

[0109]

A second aspect of the present disclosure relates to the control method according to the first aspect, in which, in the step of reversing the moving body 10 in the Y2 direction, the moving body 10 is reversed in the Y2 direction in a case where the updated avoidance path capable of avoiding the obstacle P is not generatable. According to the present disclosure, in a case where the updated avoidance path that can avoid the obstacle P cannot be generated, the moving body 10 is reversed, so that the obstacle P can be appropriately avoided.

[0110]

A third aspect of the present disclosure relates to the control method according to the first or second aspect, in which, in the step of reversing the moving body 10 in the Y2 direction, the moving body 10 is reversed in the Y2 direction in a case where the updated avoidance path that merges into the reference path R0 on a Y1 direction side with respect to the obstacle P while avoiding the obstacle P is not generatable. According to the present disclosure, in a case where the updated avoidance path that merges into the reference path R0 while avoiding the obstacle P cannot be generated, the moving body 10 is reversed, so that the obstacle P can be appropriately avoided.

[0111]

A fourth aspect of the present disclosure relates to the control method according to any one of the first to third aspects, in which, in the step of reversing the moving body 10 in the Y2 direction, a retract path R3 that extends toward the Y2 direction is set based on a detection result of the sensor 26A, and the moving body 10 is reversed in the Y2 direction along the retract path R3. According to the present disclosure, the retract path R3 is set based on the detection result of the sensor 26A, so that the moving body 10 can appropriately reverse while avoiding the obstacle P.

[0112]

A fifth aspect of the present disclosure relates to the control method according to any one of the first to third aspects, in which, in the step of reversing the moving body 10 in the Y2 direction, a retract path R3 that extends toward the Y2 direction is set based on the avoidance path R2, and the moving body 10 is reversed in the Y2 direction along the retract path R3. According to the present disclosure, the retract path R3 is set based on the avoidance path R2, so that the moving body 10 can appropriately reverse while avoiding the obstacle P.

[0113]

A sixth aspect of the present disclosure relates to the control method according to any one of the first to fifth aspects, further including: a step of updating the reference path R0 such that the moving body 10 passes through a position that does not interfere with the obstacle P after the moving body 10 is reversed in the Y2 direction, and moving the moving body 10 along the updated reference path R0. According to the present disclosure, the reference path R0 is updated after the reversing, so that the obstacle P can be appropriately avoided by using the updated reference path R0 even in a case where the obstacle P cannot be avoided on the avoidance path R2.

[0114]

A seventh aspect of the present disclosure relates to the control method according to any one of the first to sixth aspects, further including: a step of stopping the moving body 10 in a case where the obstacle P is present on the side toward the Y1 direction; a step of setting a reverse path R1 that returns to a reverse position located on a side toward the Y2 direction based on the reference path R0; and a step of moving the stopped moving body 10 to the reverse position along the reverse path R1, in which, in the step of moving the moving body 10 along the avoidance path R2, the moving body

10 that has moved to the reverse position is moved along the avoidance path R2. According to the present disclosure, in a case where the obstacle P is detected, the moving body 10 is stopped and reversed, and then the path is switched to the avoidance path R2, so that the obstacle P can be appropriately avoided.

[0115]

An eighth aspect of the present disclosure relates to a program for causing a computer to execute a control method of a moving body 10 that automatically moves, the program causing the computer to execute: a step of moving the moving body 10 along a reference path R0; a step of causing a sensor 26A provided on the moving body 10 to detect an obstacle P located on a side toward a Y1 direction that is a traveling direction of the moving body 10 when the moving body 10 is moving along the reference path R0; a step of setting an avoidance path R2 that extends toward the Y1 direction while avoiding the obstacle P in a case where the obstacle P is present on the side toward the Y1 direction; a step of moving the moving body 10 along the avoidance path R2; a step of determining whether or not an updated avoidance path that is a different avoidance path R2 satisfying a predetermined condition is generatable when the moving body 10 is moving along the avoidance path R2; and a step of reversing the moving body 10 in a Y2 direction opposite to the Y1 direction in a case where the updated avoidance path satisfying the predetermined condition is not generatable. According to the present disclosure, it is possible to appropriately avoid the obstacle.

[0116]

A ninth aspect of the present disclosure relates to a moving body 10 that automatically moves, including: a movement control unit 82 that moves the moving body 10 along a reference path R0; a detection control unit 84 that causes a sensor 26A provided on the moving body 10 to detect an obstacle P located on a side toward a Y1

direction that is a traveling direction of the moving body 10 when the moving body 10 is moving along the reference path R0; and an avoidance path acquisition unit 88 that acquires an avoidance path R2 that extends toward the Y1 direction while avoiding the obstacle P in a case where the obstacle P is present on the side toward the Y1 direction. The movement control unit 82 moves the moving body 10 along the avoidance path R2. The movement control unit 82 reverses the moving body 10 in a Y2 direction in a case where an updated avoidance path that is a different avoidance path R2 satisfying a predetermined condition is not generatable when the moving body 10 is moving along the avoidance path R2. According to the present disclosure, it is possible to appropriately avoid the obstacle.

[0117]

While the embodiments of the present disclosure have been described above, the present disclosure is not limited to the foregoing embodiments. Further, the above-described components include components that can be readily conceived by those skilled in the art, components that are substantially identical, and components falling within the so-called scope of equivalents. Furthermore, the above-described components can be combined as appropriate. Furthermore, various omissions, replacements, or modifications of the above-described components can be made without departing from the gist of the above-described embodiments.

Reference Signs List

[0118]

10: moving body

12: management device

14: information processing device

26A: sensor

80: reference path acquisition unit

82: movement control unit

84: detection control unit

86: reverse path acquisition unit

88: avoidance path acquisition unit

P: obstacle

R0: reference path

R1: reverse path

R2: avoidance path

R3: retract path