

DESCRIPTION

Title of Invention

GRIPPING DEVICE AND CONTROL METHOD FOR GRIPPING DEVICE

Technical Field

[0001]

The present invention relates to a gripping device and a control method for the gripping device.

Background Art

[0002]

There is a known transport device such as a palletizing device that loads an article on a tray such as a pallet. For example, PTL 1 discloses a gripping device that grips an upper surface and a side surface of an article by suction in a transport device.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2022-179338

Summary of Invention

Technical Problem

[0004]

In the gripping device of PTL 1, in a state where the article is not gripped, an angle formed by a suction surface of a side-surface pad and a suction surface of an upper-surface pad is 93 degrees or more and 135 degrees or less due to a biasing force of a coil

spring. In a state where the article is gripped, the side-surface pad holds the side surface of the article by suction. That is, even for an article that does not require the support by the side-surface pad, such as a lightweight article or a small article, it is necessary to load the article on four corners or unload the article from the four corners while changing a position of the side-surface pad in a plan view in order to avoid interference between other articles and the side-surface pad.

[0005]

The present disclosure has been made to solve the above problem, and an object of the present disclosure is to provide a gripping device and a control method for the gripping device capable of improving transport capability.

Solution to Problem

[0006]

In order to achieve the above object, according to an aspect of the present disclosure, there is provided a gripping device including an upper-surface grip portion having a first suction surface that is capable of holding an upper surface of an article by suction, a side-surface grip portion having a second suction surface that is capable of holding a side surface of the article by suction, and a flip-up mechanism that is capable of switching between a first state where the side-surface grip portion is positioned below a lower end of the upper-surface grip portion and a second state where the side-surface grip portion is positioned above the lower end of the upper-surface grip portion.

[0007]

In order to achieve the above object, according to an aspect of the present disclosure, there is provided a control method for the gripping device, the control method including a transport target data acquisition step of acquiring transport target data indicating data relating to an article to be transported by the gripping device, a

captured image data acquisition step of acquiring captured image data in which a predetermined region including an article to be unloaded or a region on which an article is loaded is imaged, a determination step of determining, based on the transport target data, whether or not side-surface gripping of the article by the side-surface grip portion is required for the transport of the article, a switching step of switching the side-surface grip portion to the second state in a case where it is determined in the determination step that the side-surface gripping is not required, and a transport step of supporting and transporting the article with at least the upper-surface grip portion.

Advantageous Effects of Invention

[0008]

According to the present disclosure, it is possible to obtain an effect of improving the transport capability.

Brief Description of Drawings

[0009]

FIG. 1 is a schematic diagram of a gripping device according to the present embodiment.

FIG. 2 is a schematic diagram showing a 90° flip-up aspect of the gripping device shown in FIG. 1.

FIG. 3 is a schematic diagram showing a 180° flip-up aspect of the gripping device shown in FIG. 1.

FIG. 4 is a schematic block diagram of the gripping device shown in FIG. 1.

FIG. 5 is a flowchart describing a processing flow of a control device.

FIG. 6 is a plan view schematically describing an unloading operation by the gripping device.

FIG. 7 is a sectional view taken along line II-II shown in FIG. 6.

FIG. 8 is a sectional view of a state after FIG. 7.

FIG. 9 is a plan view schematically describing the unloading operation by a gripping device of a comparative example.

FIG. 10 is a sectional view taken along line II-II shown in FIG. 9.

FIG. 11 is a plan view schematically describing the unloading operation by the gripping device of the comparative example.

FIG. 12 is a sectional view taken along line II-II shown in FIG. 11.

[0010]

(Embodiment)

Hereinafter, an embodiment according to the present disclosure will be described in detail based on drawings. The invention is not limited to the embodiment. Further, components in the following embodiment include components that can be easily replaced by those skilled in the art, components that are substantially the same, or components that fall within an equivalent range. Furthermore, the components in the following embodiment can be omitted, replaced, or changed in various ways without departing from the gist of the present disclosure. In the following embodiment, in order to exemplify the embodiment, necessary components will be described, and other components will be omitted. The same reference numerals will be assigned to the same components, and different reference numerals will be assigned to different components.

[0011]

FIG. 1 is a schematic diagram of a gripping device according to the present embodiment. FIG. 2 is a schematic diagram showing a 90° flip-up aspect of the gripping device shown in FIG. 1. FIG. 3 is a schematic diagram showing a 180° flip-up aspect of the gripping device shown in FIG. 1. FIG. 4 is a schematic block diagram of the gripping device shown in FIG. 1. A gripping device 1 shown in FIGS. 1 to 4 is

a device that is attached to a palletizing device as a transport device to load an article on a pallet, unload an article from the pallet, or reload an article from any pallet onto another pallet in a facility managed by logistics such as a warehouse.

[0012]

According to the Japan Pallet Association, a pallet is defined as “a structure having a surface for placing cargo bundled into one unit, and capable of performing all of loading, transportation, and storage by human power or a dedicated vehicle such as a forklift. This includes those with superstructures.” In the present embodiment, the pallet refers to a container or a platform on which an article R is loaded. That is, the pallet referred to here is not limited to a so-called flat plate-shaped platform, but may have any shape, including a cart or the like. The article R is loaded on the pallet, and is, for example, a product to be shipped. The article R is referred to as including a corrugated cardboard box or the like for packing a product or the like. The article R has a shape with at least a flat upper surface. In the present embodiment, a corrugated cardboard box having a rectangular parallelepiped shape is assumed.

[0013]

As shown in FIGS. 1 to 3, the gripping device 1 includes a base portion 10, an upper-surface grip portion 20, a side-surface grip portion 30, a first arm portion 40, a second arm portion 50, and a flip-up mechanism 60. Further, as shown in FIG. 4, the gripping device 1 further includes an imaging device 70, an input/output device 80, and a control device 90 that controls operations of the respective portions of the gripping device 1. In the present embodiment, the fact that the gripping device 1 includes the imaging device 70, the input/output device 80, and the control device 90 is assumed to also include an aspect in which functions of the respective devices are configured as a part of functions of the palletizing device to which the gripping device 1 is attached or

a transport system in which the palletizing device is deployed.

[0014]

In the present embodiment, a direction that is perpendicular to a second facing surface 30a facing a side surface of the article R in a case where the side-surface grip portion 30 supports the side surface of the article R is defined as an X-axis direction, a direction that is parallel to a rotary shaft A of the flip-up mechanism 60 is defined as a Y-axis direction, and a direction that is orthogonal to the X-axis direction and the Y-axis direction and that is perpendicular to a first facing surface 20a facing an upper surface of the article R in a case where the upper-surface grip portion 20 supports the upper surface of the article R is defined as a Z-axis direction. At least during the operation of the gripping device 1, the X-axis direction and the Y-axis direction correspond to a horizontal direction, and the Z-axis direction corresponds to a vertical direction.

[0015]

The base portion 10 shown in FIGS. 1 to 3 is connected to a tip of an arm of the palletizing device to which the gripping device 1 is attached via a turning shaft portion 12, a turning mechanism 14, and an elevating mechanism 16. The turning shaft portion 12 is fixed to an upper surface side of the base portion 10 such that an axial center of the turning shaft portion 12 is parallel to the Z-axis direction. The base portion 10 and the turning shaft portion 12 are supported rotatably in a rotation direction ϕ around the axial center of the turning shaft portion 12 with respect to the arm of the palletizing device.

[0016]

The turning mechanism 14 shown in FIG. 4 causes the base portion 10 and the turning shaft portion 12 to rotate in the rotation direction ϕ . For example, in a case where the palletizing device is a multi-joint robot, the rotation of the turning shaft

portion 12 by the turning mechanism 14 corresponds to an operation of a sixth axis of the multi-joint robot. The turning mechanism 14 is realized by a well-known mechanism such as a rotary actuator including a motor, a rack and pinion mechanism including an air cylinder, or a wire or link mechanism. A control unit 96 of the control device 90 controls the operation of the turning mechanism 14.

[0017]

The elevating mechanism 16 causes the base portion 10 and the turning shaft portion 12 to linearly move in a vertical direction V parallel to the Z-axis direction. For example, in a case where the palletizing device is a multi-joint robot, the linear motion of the turning shaft portion 12 by the elevating mechanism 16 is realized by a cooperation of a plurality of axes of the multi-joint robot. In a case where the palletizing device is a Cartesian robot, the linear motion of the turning shaft portion 12 by the elevating mechanism 16 corresponds to an operation of a linear motion joint of the Cartesian robot in a vertical direction. In this case, the elevating mechanism 16 is realized by a well-known mechanism such as a linear motion actuator including a motor or an air cylinder, or a rack and pinion mechanism. The control unit 96 of the control device 90 controls the operation of the elevating mechanism 16.

[0018]

The upper-surface grip portion 20 is provided below the base portion 10. The upper-surface grip portion 20 has, as a lower surface, the first facing surface 20a facing the upper surface of the article R. The upper-surface grip portion 20 is fixed to the base portion 10 such that the first facing surface 20a is perpendicular to the Z-axis direction. The upper-surface grip portion 20 moves up and down and turns in conjunction with an elevating operation and a turning operation of the base portion 10 and the turning shaft portion 12. The upper-surface grip portion 20 has a first suction

portion 22 capable of holding the article R by suction on the first facing surface 20a.

[0019]

The first suction portion 22 is depicted in one block shape in the examples shown in FIGS. 1 to 3, but may be, for example, a plurality of suction pads protruding downward from the first facing surface 20a of the upper-surface grip portion 20. The first suction portion 22 has a first suction surface 22a at a lower end of the first suction portion 22. The first suction portion 22 holds the upper surface of the article R by suction with the first suction surface 22a in a state where the first suction surface 22a is in contact with the upper surface of the article R, by an operation of a first suction mechanism 24 shown in FIG. 4. The first suction mechanism 24 includes, for example, a vacuum generator that is connected to the first suction surface 22a via an air pipe (not shown) to suck air from the first suction surface 22a. For example, in a case where the first suction portion 22 is configured to include a plurality of suction pads, each suction pad is connected to the first suction mechanism 24, which is the vacuum generator, via the air pipe. The control unit 96 of the control device 90 controls the operation of the first suction mechanism 24.

[0020]

The side-surface grip portion 30 is provided on a side portion of the base portion 10 in the X-axis direction via the first arm portion 40, the second arm portion 50, and the flip-up mechanism 60. The side-surface grip portion 30 has the second facing surface 30a facing the side surface of the article R. The side-surface grip portion 30 can be moved in a longitudinal direction of the first arm portion 40 with respect to the base portion 10 by a first expansion and contraction mechanism 44 described below. Further, the side-surface grip portion 30 can be moved in a longitudinal direction of the second arm portion 50 with respect to the base portion 10 by a second expansion and

contraction mechanism 54 described below. Further, the side-surface grip portion 30 can be rotated in a rotation direction θ around the rotary shaft A of the flip-up mechanism 60 with respect to the base portion 10 by the flip-up mechanism 60. The rotary shaft A is a horizontal axis parallel to both the first suction surface 22a of the upper-surface grip portion 20 and a second suction surface 32a of the side-surface grip portion 30.

[0021]

The side-surface grip portion 30 is movable relative to the upper-surface grip portion 20 in an X-Z plane, by the first expansion and contraction mechanism 44, the second expansion and contraction mechanism 54, and the flip-up mechanism 60. In other words, the first expansion and contraction mechanism 44 and the second expansion and contraction mechanism 54 are moving mechanisms that cause the side-surface grip portion 30 to move relative to the upper-surface grip portion 20. The side-surface grip portion 30 of the present embodiment may be configured to be movable relative to the upper-surface grip portion 20 in the Y-axis direction, although the side-surface grip portion 30 does not move relative to the upper-surface grip portion 20 in the Y-axis direction. The side-surface grip portion 30 has a second suction portion 32 capable of holding the article R by suction on the second facing surface 30a.

[0022]

The second suction portion 32 is depicted in one block shape in the examples shown in FIGS. 1 to 3, but may be, for example, a plurality of suction pads protruding from the second facing surface 30a of the side-surface grip portion 30. The second suction portion 32 has the second suction surface 32a at an end portion on a side opposite to a second facing surface 30a side. The second suction portion 32 holds the side surface of the article R by suction with the second suction surface 32a in a state where the second suction surface 32a is in contact with the side surface of the article R, by an

operation of a second suction mechanism 34 shown in FIG. 4. The second suction mechanism 34 includes, for example, a vacuum generator that is connected to the second suction surface 32a via an air pipe (not shown) to suck air from the second suction surface 32a. For example, in a case where the second suction portion 32 is configured to include a plurality of suction pads, each suction pad is connected to the second suction mechanism 34, which is the vacuum generator, via the air pipe. The control unit 96 of the control device 90 controls the operation of the second suction mechanism 34.

[0023]

The second facing surface 30a of the side-surface grip portion 30 faces the side surface of the article R, in the aspect shown in FIG. 1 in which the longitudinal direction of the first arm portion 40 is parallel to the X-axis direction and the longitudinal direction of the second arm portion 50 is parallel to the Z-axis direction. In this case, the second suction surface 32a of the second suction portion 32 faces the side surface of the article R. Further, in this case, the entire surface of the second suction surface 32a is located below the first suction surface 22a. The second facing surface 30a of the side-surface grip portion 30 faces vertically downward, in the aspect shown in FIG. 2 in which the longitudinal direction of the first arm portion 40 is parallel to the Z-axis direction and the longitudinal direction of the second arm portion 50 is parallel to the X-axis direction. In this case, the second suction surface 32a of the second suction portion 32 faces vertically downward. Further, in this case, the second suction surface 32a is located above the first suction surface 22a by a distance B.

[0024]

The first arm portion 40 is provided on the side portion of the base portion 10 in the X-axis direction, via the second arm portion 50 and the flip-up mechanism 60. The first arm portion 40 has a first support portion 42 and the first expansion and

contraction mechanism 44. The first support portion 42 is located on one end side of the first arm portion 40 in the longitudinal direction. The first support portion 42 is connected to the second arm portion 50. The first support portion 42 supports the first expansion and contraction mechanism 44, and is connected to the side-surface grip portion 30 via the first expansion and contraction mechanism 44. The first support portion 42 has a frame shape that accommodates and supports a first fixing portion 44a of the first expansion and contraction mechanism 44 in the present embodiment. The first expansion and contraction mechanism 44 extends along the longitudinal direction of the first arm portion 40, and is capable of expanding and contracting in a first expansion and contraction direction F1 that is the longitudinal direction of the first arm portion 40. The first expansion and contraction mechanism 44 is expanded and contracted in advance according to a width dimension w of the article R such that the second suction surface 32a comes into contact with the side surface of the article R, in the aspect shown in FIG. 1 in which the longitudinal direction of the first arm portion 40 is parallel to the X-axis direction and the longitudinal direction of the second arm portion 50 is parallel to the Z-axis direction.

[0025]

The first expansion and contraction mechanism 44 includes the first fixing portion 44a and a first movable portion 44b in the present embodiment. The first fixing portion 44a is fixed to the first support portion 42. The first fixing portion 44a supports the first movable portion 44b such that the first movable portion 44b is capable of linearly moving in the first expansion and contraction direction F1 within a predetermined range. The first movable portion 44b is movable in the first expansion and contraction direction F1 with respect to the first fixing portion 44a. The first fixing portion 44a supports one end side of the first movable portion 44b in the longitudinal

direction. The other end side of the first movable portion 44b in the longitudinal direction is fixed to the side-surface grip portion 30. The first expansion and contraction mechanism 44 is realized by, for example, a well-known mechanism such as a cylinder having a tubular first fixing portion 44a and a rod-shaped first movable portion 44b, an electric actuator, or a wire or link mechanism.

[0026]

The second arm portion 50 is provided on the side portion of the base portion 10 in the X-axis direction, via the flip-up mechanism 60. The second arm portion 50 has a second support portion 52 and the second expansion and contraction mechanism 54. The second support portion 52 is located on one end side of the second arm portion 50 in the longitudinal direction. The second support portion 52 is connected to the flip-up mechanism 60. The second support portion 52 supports the second expansion and contraction mechanism 54, and is connected to the first support portion 42 of the first arm portion 40 via the second expansion and contraction mechanism 54. The second support portion 52 has a frame shape that accommodates and supports a second fixing portion 54a of the second expansion and contraction mechanism 54 in the present embodiment. The second expansion and contraction mechanism 54 extends along the longitudinal direction of the second arm portion 50, and is capable of expanding and contracting in a second expansion and contraction direction F2 that is the longitudinal direction of the second arm portion 50. The second expansion and contraction mechanism 54 is expanded and contracted in advance according to a height dimension h of the article R such that the second suction surface 32a comes into contact with a suitable height position on the side surface of the article R, in the aspect shown in FIG. 1 in which the longitudinal direction of the first arm portion 40 is parallel to the X-axis direction and the longitudinal direction of the second arm portion 50 is parallel to the Z-

axis direction.

[0027]

The second expansion and contraction mechanism 54 includes the second fixing portion 54a and a second movable portion 54b in the present embodiment. The second fixing portion 54a is fixed to the second support portion 52. The second fixing portion 54a supports the second movable portion 54b such that the second movable portion 54b is capable of linearly moving in the second expansion and contraction direction F2 within a predetermined range. The second movable portion 54b is movable in the second expansion and contraction direction F2 with respect to the second fixing portion 54a. The second fixing portion 54a supports one end side of the second movable portion 54b in the longitudinal direction. The other end side of the second movable portion 54b in the longitudinal direction is fixed to the first support portion 42 of the first arm portion 40. The second expansion and contraction mechanism 54 is realized by, for example, a well-known mechanism such as a cylinder having a tubular second fixing portion 54a and a rod-shaped second movable portion 54b, an electric actuator, or a wire or link mechanism.

[0028]

The flip-up mechanism 60 can switch between a first state where the side-surface grip portion 30 is positioned below a lower end (the first suction surface 22a of the first suction portion 22 in the present embodiment) of the upper-surface grip portion 20 (state shown in FIG. 1) and a second state where the side-surface grip portion 30 is positioned above the lower end of the upper-surface grip portion 20 (state shown in FIGS. 2 and 3). The flip-up mechanism 60 is connected to the upper-surface grip portion 20 via the base portion 10. Further, the flip-up mechanism 60 is connected to the side-surface grip portion 30, via the first arm portion 40 and the second arm portion

50. The flip-up mechanism 60 of the present embodiment is provided on the side portion of the base portion 10 in the X-axis direction. The flip-up mechanism 60 causes the second arm portion 50, the first arm portion 40, and the side-surface grip portion 30 to rotate with respect to the base portion 10, in the rotation direction θ around the rotary shaft A parallel to the Y-axis direction.

[0029]

The flip-up mechanism 60 has a fixing portion 62 and a rotation portion 64 in the present embodiment. The fixing portion 62 is provided in a manner fixed to a connection portion 10a of the base portion 10. That is, the fixing portion 62 moves integrally with the base portion 10 and the upper-surface grip portion 20. The rotation portion 64 is rotatable in the rotation direction θ around the rotary shaft A with respect to the fixing portion 62. The rotation portion 64 is fixed to the second support portion 52 of the second arm portion 50. The flip-up mechanism 60 is realized by, for example, a well-known mechanism such as a rotary actuator including a motor, a rack and pinion mechanism including an air cylinder, or a wire or link mechanism. The flip-up mechanism 60 has a lock mechanism (not shown) capable of positioning a position of the rotation portion 64 in the rotation direction θ with respect to the fixing portion 62. The lock mechanism is realized by a well-known mechanism such as an air lock using high-pressure air, a mechanical lock driven by a motor, or a solenoid lock using an electromagnetic solenoid.

[0030]

With the flip-up mechanism 60, the side-surface grip portion 30, the first arm portion 40, and the second arm portion 50 can be rotated in the rotation direction θ around the rotary shaft A between a 0° position shown in FIG. 1, a 90° position shown in FIG. 2, and a 180° position shown in FIG. 3. Further, with the lock mechanism (not

shown), the side-surface grip portion 30, the first arm portion 40, and the second arm portion 50 can be positioned at any position between the 0° position shown in FIG. 1 and the 180° position shown in FIG. 3. At the 0° position shown in FIG. 1, the first arm portion 40 is located below the second arm portion 50, and the second suction surface 32a of the side-surface grip portion 30 is located below the first suction surface 22a of the upper-surface grip portion 20 and faces the side surface of the article R. At the 90° position shown in FIG. 2, the second suction surface 32a of the side-surface grip portion 30 faces vertically downward, and is located above the first suction surface 22a of the upper-surface grip portion 20 by the distance B. At the 180° position shown in FIG. 3, the second suction surface 32a of the side-surface grip portion 30 faces the X-axis direction on a side opposite to the base portion 10, and the first arm portion 40 is located above the second arm portion 50.

[0031]

The imaging device 70 images the pallet that is a target on which the article R is loaded or unloaded, the article R loaded on the pallet, and disposition of stacking of the articles R, and outputs image data, in which a position or individual article of an imaging target can be identified, to the control device 90. The imaging device 70 is disposed at a position where the pallet or the article R loaded on the pallet is observable. The imaging device 70 includes one or a plurality of cameras.

[0032]

The input/output device 80 includes an input device for inputting various types of information for operating the gripping device 1 by an operator, and an output device for presenting various types of information to the operator. The input device is realized by, for example, a keyboard, a mouse, a physical switch, a button, or a touch panel. The output device is realized by, for example, a display device including a liquid crystal

display device, an organic electro luminescence (EL) display device, or the like, a light-emitting device including a light emitting diode (LED) or the like, or a speaker. The input/output device 80 may be an information terminal capable of inputting and outputting various types of information.

[0033]

The control device 90 is a computer that controls the gripping device 1. The control device 90 has a communication unit 92, a storage unit 94, and the control unit 96. The communication unit 92 is a module that is used for the control unit 96 and communicates with an external device such as a management device 100, and may include, for example, an antenna. A communication method by the communication unit 92 is assumed to be wireless communication in the present embodiment, but any communication method may be employed. The storage unit 94 is a memory that stores calculation contents or a program of the control unit 96 and various types of information acquired from the management device 100 via the communication unit 92, and includes, for example, at least one of a main storage device, such as a random-access memory (RAM) and a read-only memory (ROM), and an external storage device, such as a hard disk drive (HDD).

[0034]

The control unit 96 is a calculation processing device, and includes, for example, a calculation circuit such as a central processing unit (CPU). The control unit 96 reads out and executes a program (software) from the storage unit 94 to execute various types of processing. The control unit 96 may execute the processing using one CPU, or may include a plurality of CPUs to execute the processing using the plurality of CPUs.

[0035]

The control unit 96 acquires upstream data from the management device 100

via the communication unit 92. The upstream data includes, for example, a type, weight, and dimension of the article R loaded on the pallet, box perforations and gluing points, and transport target data such as the number of articles R, disposition of each article R on the pallet or a position of each article R loaded on the pallet, and an order in which the articles R are unloaded from the pallet or an order in which the articles R are loaded on the pallet. The control unit 96 causes the imaging device 70 to perform the imaging at any time to acquire the image data. The control unit 96 performs image processing on the acquired image data to recognize the number, position, shape, size, and the like of the article R present in the image data. The control unit 96 determines whether or not side-surface gripping by the side-surface grip portion 30 is required, and a flip-up direction and angle of the side-surface grip portion 30, based on the image data and the transport target data. The control unit 96 controls the turning mechanism 14, the elevating mechanism 16, the first suction mechanism 24, the second suction mechanism 34, the first expansion and contraction mechanism 44, the second expansion and contraction mechanism 54, and the flip-up mechanism 60, based on the determined contents and the transport target data. Further, the control unit 96 executes control of moving the gripping device 1 itself in the horizontal direction, in the palletizing device to which the gripping device 1 is attached. In a case where the palletizing device is a multi-joint robot, the movement of the gripping device 1 itself in the horizontal direction is realized by a cooperation of a plurality of axes of the multi-joint robot.

[0036]

The management device 100 is a system that manages the operation of each device in a logistics management facility in which the gripping device 1 of the present embodiment is deployed. The management device 100 is, for example, a warehouse control system (WCS) or a warehouse management system (WMS), but is not limited to

the WCS and the WMS. Any system may be employed, and, for example, a back-end system such as another production management system may be employed. The management device 100 is provided at any position. The management device 100 may be provided in the facility where the gripping device 1 is deployed, or may be provided at a position remote from the facility to manage the facility from the remote position.

[0037]

(Processing of Control Device)

Next, a flow of processing of determining whether or not the side-surface gripping by the side-surface grip portion 30 is required, in the transport by the gripping device 1, will be described. Here, a case will be described in which a plurality of articles R loaded on the pallet are unloaded. FIG. 5 is a flowchart describing a processing flow of the control device. The control unit 96 of the control device 90 executes the processing shown in FIG. 5 based on the program and the data stored in advance in the storage unit 94. For example, in a case where the control device 90 receives, from the management device 100, a predetermined control signal for instructing the gripping device 1 to be driven, the processing starts by proceeding to step S10 shown in FIG. 5.

[0038]

The control device 90 acquires the transport target data (step S10). In the present embodiment, the control device 90 acquires the transport target data from the management device 100 via the communication unit 92. In the present processing, the transport target data includes at least data serving as a determination material for determining whether or not the side-surface gripping by the side-surface grip portion 30 is required in a case where the gripping device 1 lifts each of the articles R to be loaded and unloaded. For example, in a case where the article R is small and light, the side-

surface gripping is not required. Further, the transport target data includes data indicating the number, position (coordinates on the pallet), and order of loading and unloading of each of the articles R to be loaded and unloaded.

[0039]

The control device 90 sets the number of execution times i to $i = 1$, and starts loop processing (step S12). In the loop processing, processing from step S14 to step S20 is repeatedly executed n times while $i \leq n$ is satisfied. Here, n is the number of articles R loaded on the pallet, and i indicates the order in which the articles R are unloaded from the pallet.

[0040]

The control device 90 acquires captured image data (step S14). In the present embodiment, the control device 90 causes the imaging device 70 to image a predetermined region including an i -th article R to be loaded and unloaded. The imaging device 70 outputs, to the control device 90, the captured image data indicating data of a captured image. For example, the captured image data may be in association with coordinate data in a coordinate system based on a predetermined position of the gripping device 1 or a facility where the gripping device 1 is deployed. The control device 90 performs the image processing on the captured image data to recognize the position, shape, size, and the like of the i -th article R to be loaded and unloaded.

[0041]

The control device 90 determines whether or not the side-surface gripping is required (step S16). In the present embodiment, the control device 90 determines whether or not the side-surface gripping is required, based on the transport target data acquired in step S10. For example, in a case where an i -th article R to be unloaded can be sufficiently lifted only by the upper-surface grip portion 20, it is determined that the

side-surface gripping is not required. In a case where the control device 90 determines that the side-surface gripping is required (Yes in step S16), the processing proceeds to step S20. In a case where the control device 90 determines that the side-surface gripping is not required (No in step S16), the processing proceeds to step S18.

[0042]

In a case where the control device 90 determines that the side-surface gripping is not required (No in step S16), the control device 90 determines the flip-up direction and angle of the side-surface grip portion 30 based on the captured image data acquired in step S14 (step S18). The flip-up direction indicates a position of the side-surface grip portion 30 in the rotation direction ϕ . The flip-up angle indicates a position of the side-surface grip portion 30 in the rotation direction θ . In a case where there is an obstacle around the i-th article R to be unloaded, the side-surface grip portion 30 may interfere with the obstacle. Specifically, in a case where another article R is loaded adjacent to a side-surface grip portion 30 side of the article R (right side in FIG. 1), the side-surface grip portion 30 may interfere with the adjacent article R in a case where the upper-surface grip portion 20 is in contact with the upper surface of the article R.

[0043]

The position of the side-surface grip portion 30 in the rotation direction θ and the position of the side-surface grip portion 30 in the rotation direction ϕ at a point in time at which step S16 starts are, for example, positions of the side-surface grip portion 30 in a case where an (i-1)-th article R is unloaded. In step S18, the control device 90 first acquires the position of the side-surface grip portion 30 in the rotation direction ϕ . Next, the control device 90 determines whether or not there is another article R serving as an obstacle in a direction of the side-surface grip portion 30 for the i-th article R, based on the captured image data acquired in step S14. In a case where it is determined

that there is no other article R serving as an obstacle, the control device 90 determines to maintain the flip-up direction and angle of the side-surface grip portion 30, and the processing proceeds to step S20.

[0044]

In a case where the control device 90 determines that there is another article R serving as an obstacle, the control device 90 determines the flip-up angle of the side-surface grip portion 30 such that the side-surface grip portion 30 can avoid the obstacle. For example, in a case where the control device 90 determines that the height dimension h of another article R serving as an obstacle is equal to or less than the height dimension h of the i-th article R, based on at least one of the transport target data and the captured image data, the control device 90 determines the flip-up angle to be 90° (position shown in FIG. 2). For example, in a case where the control device 90 determines that the height dimension h of another article R serving as an obstacle is larger than the height dimension h of the i-th article R and is smaller than a predetermined threshold value, based on at least one of the transport target data and the captured image data, the control device 90 determines the flip-up angle to be 180° (position shown in FIG. 3). The predetermined threshold value is set in advance by the configuration of the gripping device 1 other than the side-surface grip portion 30. For example, the predetermined threshold value is set in a range where the second support portion 52 does not interfere at the position of 180° shown in FIG. 3, in the configuration of the present embodiment.

[0045]

For example, in a case where the control device 90 determines that the height dimension h of another article R serving as an obstacle is equal to or larger than the predetermined threshold value, based on at least one of the transport target data and the captured image data, the control device 90 determines to cause the side-surface grip

portion 30 to move in the rotation direction ϕ . The control device 90 determines the flip-up angle at which the side-surface grip portion 30 can avoid another article R serving as an obstacle in the above procedure, in a state where the side-surface grip portion 30 has moved in the 90°, 180°, or 270° rotation direction ϕ . In a case where the control device 90 determines the flip-up direction and angle of the side-surface grip portion 30, the processing proceeds to step S20.

[0046]

The control device 90 transports (unloads) the i-th article R (step S20). First, the control device 90 controls the turning mechanism 14 and the flip-up mechanism 60 according to the flip-up direction and angle determined in step S18 to position the side-surface grip portion 30 in a predetermined posture. Further, in a case where the side-surface gripping by the side-surface grip portion 30 is performed, the control device 90 controls the first expansion and contraction mechanism 44 and the second expansion and contraction mechanism 54 to expand and contract the first arm portion 40 and the second arm portion 50, such that the side-surface grip portion 30 is positioned at a suitable position on the side surface of the article R, based on the width dimension w of the i-th article R (refer to FIG. 1).

[0047]

Next, the control device 90 controls the gripping device 1 to move horizontally to a position where the first suction portion 22 of the upper-surface grip portion 20 faces the upper surface of the article R. Next, the control device 90 controls the elevating mechanism 16 to cause the base portion 10 and the upper-surface grip portion 20 to be lowered to a position where the first suction surface 22a of the first suction portion 22 comes into contact with the upper surface of the article R. Next, the control device 90 operates the first suction mechanism 24 to cause the upper surface of the article R to be

held by suction on the first suction surface 22a. In a case where it is determined in step S16 that the side-surface gripping is required, the control device 90 operates the second suction mechanism 34 to cause the side surface of the article R to be held by suction on the second suction surface 32a. Accordingly, the gripping device 1 supports the article R. The control device 90 causes the elevating mechanism 16 to raise the gripping device 1 that grips the article R, and then transports the gripping device 1 to a predetermined position to unload the i-th article R from the pallet.

[0048]

The control device 90 resets the number of execution times i to $i = i + 1$ in the loop processing, and returns the processing to step S14 (step S22). In a case where the processing from step S14 to step S20 is executed n times and unloading of n articles R on the pallet is completed, the loop processing is ended.

[0049]

In the processing of the present embodiment shown in FIG. 5, step S14 is performed for each article R. However, for example, in a case where the articles R are arranged in a planar shape on the pallet, that is, in a case where a plurality of articles R are not loaded in an up-down direction, step S14 in which all the articles R on the pallet are imaged may be performed only once for the first time. Further, in the processing of the present embodiment, the transport target data includes the number and position (coordinates) data of each of the articles R. However, the number and positions of the articles R may be acquired based on the captured image data in which all the articles R on the pallet are imaged.

[0050]

Further, although the above description has been made of processing in a case where the article R is unloaded from the pallet on which the plurality of articles R are

loaded, the processing of the present embodiment shown in FIG. 5 is also applicable to a case where the plurality of articles R are loaded on the pallet. In this case, in step S14, a predetermined region including a region where the articles R are scheduled to be loaded on the pallet is imaged. Further, in step S18, in a case where the i-th article R is loaded at a predetermined position on the pallet, the flip-up direction and angle are determined based on presence or absence and a dimension of an obstacle in a region adjacent to the region where the loading is scheduled. In this case, the obstacle is the loaded articles R from the first article R to the (i-1)-th article R.

[0051]

(Unloading Operation)

FIG. 6 is a plan view schematically describing the unloading operation by the gripping device. FIG. 7 is a sectional view taken along line II-II shown in FIG. 6. FIG. 8 is a sectional view of a state after FIG. 7. FIGS. 6 to 8 show the operation of unloading the article R4 among the articles R1, R2, R3, and R4 arranged on the pallet P. All of the articles R1, R2, R3, and R4 have the same dimension. In the plan view shown in FIG. 6, the article R3 is disposed adjacent to the article R4 on a left side. Further, in FIGS. 6 to 8, the gripping device 1 is depicted only with the upper-surface grip portion 20 and the side-surface grip portion 30. Further, the side-surface grip portion 30 is assumed to be at the position of 90° shown in FIG. 2.

[0052]

As shown in FIGS. 6 and 7, in a state where the first suction portion 22 of the upper-surface grip portion 20 is caused to be in contact with an upper surface of the article R4, the side-surface grip portion 30 is located above the article R3. In this case, a lower end of the second suction portion 32 of the side-surface grip portion 30 is located above the lower end of the first suction portion 22 by the distance B (refer to FIG. 2).

Therefore, the second suction portion 32 of the side-surface grip portion 30 does not come into contact with the article R3. As shown in FIG. 8, the gripping device 1 of the present embodiment can unload the article R4 only by the suction with the first suction portion 22 of the upper-surface grip portion 20.

[0053]

(Unloading Operation in Related Art)

FIGS. 9 and 11 are plan views schematically describing the unloading operation by the gripping device of a comparative example. FIG. 10 is a sectional view taken along line II-II shown in FIG. 9. FIG. 12 is a sectional view taken along line II-II shown in FIG. 11. FIGS. 9 to 12 show the operation of unloading the article R4 among the articles R1, R2, R3, and R4 arranged on the pallet P by the gripping device of the comparative example. All of the articles R1, R2, R3, and R4 have the same dimension. In the plan views shown in FIGS. 9 and 11, the article R3 is disposed adjacent to the article R4 on a left side. Further, in FIGS. 9 to 12, the gripping device of the comparative example is depicted only with the upper-surface grip portion 20 and a side-surface grip portion 30A. The side-surface grip portion 30A of the comparative example is equivalent to a state where the side-surface grip portion 30 of the present embodiment is fixed at the position of 0° shown in FIG. 1.

[0054]

As shown in FIGS. 9 and 10, in the gripping device of the comparative example, since the first suction portion 22 of the upper-surface grip portion 20 is caused to be in contact with an upper surface of the article R4, in a case where the upper-surface grip portion 20 and the side-surface grip portion 30A are lowered, the side-surface grip portion 30A collides with the upper surface of the article R3. As shown in FIGS. 11 and 12, the upper-surface grip portion 20 and the side-surface grip portion 30A are

rotated 180° in the rotation direction ϕ (refer to FIG. 1) to cause the side-surface grip portion 30A to be retracted from the position above the article R3. Accordingly, as shown in FIG. 12, the upper-surface grip portion 20 and the side-surface grip portion 30A can be lowered to the position where the first suction portion 22 of the upper-surface grip portion 20 comes into contact with the upper surface of the article R4. That is, in the gripping device of the comparative example, it can be said that means for avoiding interference between the side-surface grip portion 30A and the obstacle is limited to the rotation of the upper-surface grip portion 20 and the side-surface grip portion 30A in the rotation direction ϕ (refer to FIG. 1).

[0055]

(Operational Effects of Embodiment)

The gripping device 1 and the control method for the gripping device 1 described in the embodiment are understood as follows, for example.

[0056]

A gripping device 1 according to a first aspect includes an upper-surface grip portion 20 having a first suction surface 22a that is capable of holding an upper surface of an article R by suction, a side-surface grip portion 30 having a second suction surface 32a that is capable of holding a side surface of the article R by suction, and a flip-up mechanism 60 that is capable of switching between a first state where the side-surface grip portion 30 is positioned below a lower end of the upper-surface grip portion 20 and a second state where the side-surface grip portion 30 is positioned above the lower end of the upper-surface grip portion 20.

[0057]

In the gripping device 1 according to the first aspect, in the second state, the side-surface grip portion 30 is positioned above the lower end of the upper-surface grip

portion 20. Therefore, it is possible to lift the article R that does not need to be supported by the side-surface grip portion 30, such as the lightweight article R or the small article R, using only the upper-surface grip portion 20. In a case where the plurality of articles R are loaded on the pallet, the article R is unloaded from the pallet on which the plurality of articles R are loaded, or the article R is reloaded from one pallet to another pallet, another article R loaded around the article R to be transported may be an obstacle. However, in a case where the side-surface grip portion 30 is in the second state, the side-surface grip portion 30 is positioned above the lower end of the upper-surface grip portion 20, that is, is positioned above the upper surface of the article R. Therefore, it is possible to avoid interference with an obstacle having a height equal to or less than a height of the article R. Since the interference between another article R and the side-surface grip portion 30 can be avoided by the switching of the state of the side-surface grip portion 30, it is not necessary to load the articles at the four corners or to unload the articles from the four corners while changing the position of the side-surface grip portion 30 in a plan view as in the related art, and thus it is possible to improve transport capability.

[0058]

The gripping device 1 according to a second aspect further includes a first suction mechanism 24 that operates the suction in the first suction surface 22a in a state where the first suction surface 22a is in contact with the upper surface of the article R, and a second suction mechanism 34 that operates the suction in the second suction surface 32a in a state where the second suction surface 32a is in contact with the side surface of the article R.

[0059]

In the gripping device 1 according to the second aspect, the first suction

mechanism 24 and the second suction mechanism 34 can be operated separately. Therefore, it is possible to separately control the suction operation by the upper-surface grip portion 20 and the suction operation by the side-surface grip portion 30. That is, in a case where the article R is transported only by the upper-surface grip portion 20, it is possible to stop the second suction mechanism 34 in a case where the side-surface grip portion 30 is in the second state.

[0060]

In the gripping device 1 according to a third aspect, the flip-up mechanism 60 has a lock mechanism that positions the side-surface grip portion 30 at a position in the second state.

[0061]

In the gripping device 1 according to the third aspect, in a case where the article R is transported only by the upper-surface grip portion 20, the position of the side-surface grip portion 30 can be fixed in a case where the side-surface grip portion 30 is in the second state. Therefore, it is possible to prevent the side-surface grip portion 30 from unintentionally descending to the position in the first state or swinging. Accordingly, it is possible to stably avoid interference between another article R and the side-surface grip portion 30, and thus to stably transport the article R.

[0062]

In the gripping device 1 according to a fourth aspect, the flip-up mechanism 60 causes the side-surface grip portion 30 to rotate around a first rotary shaft (rotary shaft A) that is parallel to the first suction surface 22a and the second suction surface 32a and that is located above the side-surface grip portion 30 in the first state.

[0063]

In the gripping device 1 according to the fourth aspect, the side-surface grip

portion 30 rotates around the first rotary shaft relative to the upper-surface grip portion 20, and thus it is possible to switch the side-surface grip portion 30 between the first state and the second state. Therefore, it is possible to realize the flip-up mechanism 60 with a well-known simple configuration such as a motor with the first rotary shaft as an axial center or a rack and pinion mechanism.

[0064]

The gripping device 1 according to a fifth aspect further includes a first arm portion 40 that has one end side connected to the side-surface grip portion 30 and that is expandable and contractable in a first direction (first expansion and contraction direction F1) perpendicular to the second suction surface 32a, and a second arm portion 50 that has one end side connected to the other end side of the first arm portion 40, that has the other end side connected to the upper-surface grip portion 20 via the flip-up mechanism 60, and that is expandable and contractable in a second direction (second expansion and contraction direction F2) parallel to the second suction surface 32a and orthogonal to the first rotary shaft (rotary shaft A).

[0065]

In the gripping device 1 according to the fifth aspect, in a case where the side-surface gripping by the side-surface grip portion 30 is required, it is possible to adjust the position of the side-surface grip portion 30 relative to the position of the upper-surface grip portion 20 that supports the upper surface of the article R in accordance with the dimension of the article R. That is, in a case where the upper-surface grip portion 20 holds a central portion on the upper surface of the article R by suction, the first arm portion 40 can be expanded and contracted such that the second suction surface 32a comes into contact with the side surface of the article R. Therefore, it is possible to deal with a change in the width dimension w of the article R. Further, since the

second arm portion 50 can be expanded and contracted to change the height position of the second suction surface 32a to preferably support the side surface of the article R by the side-surface grip portion 30, it is possible to deal with a change in the height dimension h of the article R.

[0066]

In the gripping device 1 according to a sixth aspect, the flip-up mechanism 60 causes the side-surface grip portion 30 to be translationally moved in a direction perpendicular to the first suction surface 22a.

[0067]

In the gripping device 1 according to the sixth aspect, since the side-surface grip portion 30 is caused to translationally move relative to the upper-surface grip portion 20 in the direction perpendicular to the first suction surface 22a, it is possible to switch the side-surface grip portion 30 between the first state and the second state. Therefore, it is possible to realize the flip-up mechanism 60 with a well-known simple configuration such as a linear motion actuator including a motor or an air cylinder, a rack and pinion mechanism, or a wire or link mechanism.

[0068]

The gripping device 1 according to a seventh aspect further includes a turning mechanism that causes the upper-surface grip portion 20 and the side-surface grip portion 30 to rotate around a perpendicular second rotary shaft.

[0069]

In the gripping device 1 according to the seventh aspect, it is possible to switch the state of the side-surface grip portion 30 to avoid interference between another article R and the side-surface grip portion 30 without loading the articles R at the four corners or unloading the articles R from the four corners while changing the position of the side-

surface grip portion 30 in a plan view. Therefore, it is possible to reduce the number of times of the rotation operation by the turning mechanism, and thus to reduce heat generation from the device, wear of components of the turning mechanism, or the like.

[0070]

A control method for the gripping device 1 according to an eighth aspect is a control method for the gripping device 1 according to any one of the first aspect to the seventh aspect, the control method including a transport target data acquisition step (step S10) of acquiring transport target data indicating data relating to an article R to be transported by the gripping device 1, a captured image data acquisition step (step S14) of acquiring captured image data in which a predetermined region including an article R to be unloaded or a region on which an article R is loaded is imaged, a determination step (step S16) of determining, based on the transport target data, whether or not side-surface gripping of the article R by the side-surface grip portion 30 is required for the transport of the article R, a switching step (step S18) of switching the side-surface grip portion 30 to the second state in a case where it is determined in the determination step that the side-surface gripping is not required, and a transport step (step S20) of supporting and transporting the article R with at least the upper-surface grip portion 20.

[0071]

In the control method for the gripping device 1 according to the eighth aspect, it is determined, based on the transport target data, whether or not the side-surface gripping of the article R by the side-surface grip portion 30 is required, and the positioning of the side-surface grip portion 30 can be optimized, such as the positioning of the side-surface grip portion 30 in the first state in a case where the side-surface gripping is required and the positioning of the side-surface grip portion 30 in the second state in a case where the side-surface gripping is not required. Therefore, it is possible

to improve transport capability.

[0072]

In the control method for the gripping device 1 according to a ninth aspect, in the switching step (step S18), based on the captured image data, presence or absence of an obstacle that may interfere with the side-surface grip portion 30 around the article R is determined, and in a case where the obstacle is present, the side-surface grip portion 30 is caused to move relative to the upper-surface grip portion 20 to a position where the side-surface grip portion 30 is capable of avoiding the obstacle.

[0073]

In the control method for the gripping device 1 according to the ninth aspect, it is determined, based on the transport target data, whether or not the side-surface gripping of the article R by the side-surface grip portion 30 is required, and a situation around the article R, which is the transport target, is recognized based on the captured image data. Accordingly, the positioning of the side-surface grip portion 30 can be optimized, such as the positioning of the side-surface grip portion 30 in the first state in a case where the side-surface gripping is required and the positioning of the side-surface grip portion 30 in the second state in a case where the side-surface gripping is not required and there is a possibility of interference with an obstacle. Therefore, it is possible to improve transport capability.

[0074]

In the control method for the gripping device 1 according to a tenth aspect, the transport target data includes the number of articles R, a position of each article R to be loaded or a position of each article R to be unloaded, and an order in which each article R is loaded or an order in which each article R is unloaded, and the captured image data acquisition step (step S14), the determination step (step S16), the switching step (step

S18), and the transport step (step S20) are repeatedly executed after the transport target data acquisition step (step S10).

[0075]

In the control method for the gripping device 1 according to the tenth aspect, the transport target data is included, for example, in the upstream data from the management device 100 or the like of the transport system in which the gripping device 1 is deployed. With such transport target data, the order of transport of the plurality of articles R is determined in advance, and the gripping device 1 is controlled based on this. That is, since the articles R are transported one after another in a predetermined order and the positioning of the side-surface grip portion 30 can be optimized based on the transport target data and the captured image data in a case of the transport, it is possible to improve transport capability.

[0076]

The embodiment of the present disclosure has been described above. However, the embodiment is not limited to the described contents of the embodiment.

[0077]

For example, in the present embodiment, the side-surface grip portion 30 is caused to move at the position below and the position above the lower end of the upper-surface grip portion 20 by the rotation of the side-surface grip portion 30, the first arm portion 40, and the second arm portion 50 around the rotary shaft A of the flip-up mechanism 60, but the movement of the side-surface grip portion 30 may be realized by the translational movement in the Z-axis direction. That is, with the translational movement of the side-surface grip portion 30 in the direction perpendicular to the first suction surface 22a of the upper-surface grip portion 20, the flip-up mechanism 60 may cause the side-surface grip portion 30 to move at the position below and the position

above the lower end of the upper-surface grip portion 20. In this case, the flip-up mechanism 60 is realized by a well-known mechanism such as a linear motion actuator including a motor or an air cylinder, a rack and pinion mechanism, or a wire or link mechanism.

Reference Signs List

[0078]

1: gripping device

10: base portion

10a: connection portion

12: turning shaft portion

14: turning mechanism

16: elevating mechanism

20: upper-surface grip portion

20a: first facing surface

22: first suction portion

22a: first suction surface

24: first suction mechanism

30: side-surface grip portion

30a: second facing surface

32: second suction portion

32a: second suction surface

34: second suction mechanism

40: first arm portion

42: first support portion

44: first expansion and contraction mechanism

44a: first fixing portion
44b: first movable portion
50: second arm portion
52: second support portion
54: second expansion and contraction mechanism
54a: second fixing portion
54b: second movable portion
60: flip-up mechanism
62: fixing portion
64: rotation portion
70: imaging device
80: input/output device
90: control device
92: communication unit
94: storage unit
96: control unit
100: management device

Claims

[Claim 1]

A gripping device comprising:

an upper-surface grip portion having a first suction surface that is capable of holding an upper surface of an article by suction;

a side-surface grip portion having a second suction surface that is capable of holding a side surface of the article by suction; and

a flip-up mechanism that is capable of switching between a first state where the side-surface grip portion is positioned below a lower end of the upper-surface grip portion and a second state where the side-surface grip portion is positioned above the lower end of the upper-surface grip portion.

[Claim 2]

The gripping device according to claim 1, further comprising:

a first suction mechanism that operates the suction in the first suction surface in a state where the first suction surface is in contact with the upper surface of the article; and

a second suction mechanism that operates the suction in the second suction surface in a state where the second suction surface is in contact with the side surface of the article.

[Claim 3]

The gripping device according to claim 1,

wherein the flip-up mechanism has a lock mechanism that positions the side-

surface grip portion at a position in the second state.

[Claim 4]

The gripping device according to claim 1,
wherein the flip-up mechanism causes the side-surface grip portion to rotate around a first rotary shaft that is parallel to the first suction surface and the second suction surface and that is located above the side-surface grip portion in the first state.

[Claim 5]

The gripping device according to claim 4, further comprising:
a first arm portion that has one end side connected to the side-surface grip portion and that is expandable and contractable in a first direction perpendicular to the second suction surface; and
a second arm portion that has one end side connected to the other end side of the first arm portion, that has the other end side connected to the upper-surface grip portion via the flip-up mechanism, and that is expandable and contractable in a second direction parallel to the second suction surface and orthogonal to the first rotary shaft.

[Claim 6]

The gripping device according to claim 1,
wherein the flip-up mechanism causes the side-surface grip portion to be translationally moved in a direction perpendicular to the first suction surface.

[Claim 7]

The gripping device according to claim 1, further comprising:

a turning mechanism that causes the upper-surface grip portion and the side-surface grip portion to rotate around a perpendicular second rotary shaft.

[Claim 8]

A control method for the gripping device according to any one of claims 1 to 7, the control method comprising:

a transport target data acquisition step of acquiring transport target data indicating data relating to an article to be transported by the gripping device;

a captured image data acquisition step of acquiring captured image data in which a predetermined region including an article to be unloaded or a region on which an article is loaded is imaged;

a determination step of determining, based on the transport target data, whether or not side-surface gripping of the article by the side-surface grip portion is required for the transport of the article;

a switching step of switching the side-surface grip portion to the second state in a case where it is determined in the determination step that the side-surface gripping is not required; and

a transport step of supporting and transporting the article with at least the upper-surface grip portion.

[Claim 9]

The control method for the gripping device according to claim 8,

wherein in the switching step, based on the captured image data, presence or absence of an obstacle that may interfere with the side-surface grip portion around the article is determined, and in a case where the obstacle is present, the side-surface grip

portion is caused to move relative to the upper-surface grip portion to a position where the side-surface grip portion is capable of avoiding the obstacle.

[Claim 10]

The control method for the gripping device according to claim 8,
wherein the transport target data includes the number of articles, a position of each article to be loaded or a position of each article to be unloaded, and an order in which each article is loaded or an order in which each article is unloaded, and
the captured image data acquisition step, the determination step, the switching step, and the transport step are repeatedly executed after the transport target data acquisition step.