DESCRIPTION

TITLE OF INVENTION: ARTICLE MANAGEMENT DEVICE, ARTICLE MANAGEMENT METHOD, DATA STRUCTURE OF ARTICLE MANAGEMENT DATA, AND PROGRAM

TECHNICAL FIELD

[0001] The present invention relates to an article management device, an article management method, a data structure of article management data, and a program, and is particularly suitable for being used for article management.

BACKGROUND ART

[0002] Management of positions of articles, for example, articles of iron or steel including plates is performed.

In a technique described in Patent Literature 1, X-Y coordinates of an overhead traveling crane when lowering a steel plate are registered together with a steel plate number of the steel plate, to thereby manage a position of the steel plate.

[0003] Further, in a technique described in Patent Literature 2, a fixed place for a steel material indicated by three-dimensional coordinates is calculated by a fixed place calculation program based on movements in horizontal and vertical directions of a crane and an operation, for example, load detection, and fixed place information indicating the calculated fixed place is stored by being corresponded to steel material identification information of the steel material.

CITATION LIST

PATENT LITERATURE

[0004] Patent Literature 1: Japanese Patent No. 5109451

Patent Literature 2: Japanese Patent No. 3734419

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] However, in the technique described in Patent Literature 1, the information used for managing the position of the steel plate is the X-Y coordinates of the overhead traveling crane. Accordingly, the management of the position of the article can be performed only within a range in which the article can be conveyed by the overhead traveling crane. Further, in the technique described in Patent Literature 1, it is not possible to specify a Z-coordinate from the X-Y coordinates of the overhead traveling crane, and thus when a plurality of steel plates are stacked, for example, it is not possible to correctly specify the plurality of steel plates.

[0006] Further, in the technique described in Patent Literature 2, the three-dimensional coordinates of the steel material are calculated. However, it is possible to manage the position of the article only within a range in which the article can be conveyed by the crane, in a similar manner to Patent Literature 1. Further, the three-dimensional coordinates of the steel material calculated by the technique described in Patent Literature 2 are the

three-dimensional coordinates of the fixed place calculated by the fixed place calculation program. Therefore, in the technique described in Patent Literature 2, the management of the position of the steel material can be performed only at the fixed place that is previously determined by the fixed place calculation program.

[0007] In actual manufacturing sites, there is a case where manufactured products are conveyed by various conveying devices. Further, there is a case where a worker conveys manufactured products without using a conveying device. Further, there is a case where manufactured products are placed in a storage space whose address is not determined. Besides, manufactured products are placed in various ways. In the techniques described in Patent Literatures 1 and 2, it is not easy to manage positions of such manufactured products. Regarding articles other than the manufactured products, these problems exist in a similar manner.

[0008] The present invention has been made in view of the problems as described above, and an object thereof is to make it possible to properly manage a position of an article.

SOLUTION TO PROBLEM

[0009] An article management device of the present invention being an article management device that manages a position of an article, includes: one or two or more of image acquisition units each of which

acquires a captured image of a region including display information displayed on the article; an identification information acquisition unit that acquires identification information of the article; a position derivation unit that derives, based on the captured image acquired by the image acquisition unit, an information display position being a three-dimensional position at which the display information is displayed; and a storage unit that stores the information display position in the article derived by the position derivation unit, in a storage medium in association with the identification information of the article acquired by the identification information acquisition unit.

[0010] An article management method of the present invention being an article management method of managing a position of an article, includes: one or two or more of image acquisition steps of acquiring a captured image of a region including display information displayed on the article; an identification information acquisition step of acquiring identification information of the article; a position derivation step of deriving, based on the captured image acquired by the image acquisition step, an information display position being a three-dimensional position at which the display information is displayed; and a storage step of storing the information display position in the article derived by the position derivation step, in a storage medium

in association with the identification information of the article acquired by the identification information acquisition step.

[0011] A data structure of article management data of the present invention includes: display information displayed on an article; and non-display information that is not displayed on the article, in which the non-display information includes an information display position being a three-dimensional position at which the display information is displayed, and the data structure of the article management data is used for deriving, by an article management device, the information display position in the article based on a captured image of a region including the display information displayed on the article.

[0012] A program of the present invention being a program for making a computer execute processing of managing a position of an article, the program making the computer execute: one or two or more of image acquisition steps of acquiring a captured image of a region including display information displayed on the article; an identification information acquisition step of acquiring identification information of the article; a position derivation step of deriving, based on the captured image acquired by the image acquisition step, an information display position being a three-dimensional position at which the display information is displayed; and a storage step

of storing the information display position in the article derived by the position derivation step, in a storage medium in association with the identification information of the article acquired by the identification information acquisition step.

BRIEF DESCRIPTION OF DRAWINGS

[0013] [Fig. 1] Fig. 1 is a view explaining an example of a flow of a product in a factory.

[Fig. 2] Fig. 2 is a view illustrating an example of a display region with respect to a plate.

[Fig. 3A] Fig. 3A is a view illustrating an example of display contents by a stencil.

[Fig. 3B] Fig. 3B is a view illustrating an example of display contents by a label.

[Fig. 4] Fig. 4 is a view illustrating an example of a state in which plates are loaded and unloaded into and from a transport ship.

[Fig. 5] Fig. 5 is a view in which a state where a plate is lifted by a cargo handling device is seen from an extending direction of a girder (y-axis direction).

[Fig. 6A] Fig. 6A is a view illustrating a first example of a plate conveyance pattern.

[Fig. 6B] Fig. 6B is a view illustrating a second example of the plate conveyance pattern.

[Fig. 6C] Fig. 6C is a view illustrating a third example of the plate conveyance pattern.

[Fig. 6D] Fig. 6D is a view illustrating a fourth example of the plate conveyance pattern.

[Fig. 6E] Fig. 6E is a view illustrating a fifth example of the plate conveyance pattern.

[Fig. 7] Fig. 7 is a view illustrating an example of a state in which plates are loaded and unloaded into and from a transport vehicle.

[Fig. 8] Fig. 8 is a view illustrating an example of a state in which the plates were loaded into the transport vehicle.

[Fig. 9A] Fig. 9A is a view illustrating a first example of a state of plates placed in a storage space in a factory.

[Fig. 9B] Fig. 9B is a view illustrating a second example of a state of plates placed in a storage space in the factory.

[Fig. 9C] Fig. 9C is a view illustrating a third example of a state of plates placed in a storage space in the factory.

[Fig. 10] Fig. 10 is a view illustrating an example of a state where plates are processed in a production facility.

[Fig. 11] Fig. 11 is a view illustrating an example of an original plate and plates after being cut.

[Fig. 12] Fig. 12 is a view illustrating an example of a functional configuration of an article management device.

[Fig. 13] Fig. 13 is a view illustrating a first example of a management table.

[Fig. 14] Fig. 14 is a view illustrating an

example of a position in article of a stencil, and positions of components of respective display items in a display by the stencil.

[Fig. 15] Fig. 15 is a view illustrating an example of a position in article of a label, and positions of components of respective display items in a display by the label.

[Fig. 16A] Fig. 16A is a view illustrating a first example of information stored in the management table.

[Fig. 16B] Fig. 16B is a view illustrating a second example of information stored in the management table.

[Fig. 17] Fig. 17 is a flow chart explaining a first example of processing of the article management device.

[Fig. 18] Fig. 18 is a view explaining an example of a method of deriving a three-dimensional position of a display region by a stencil.

[Fig. 19] Fig. 19 is a view explaining an example of a method of deriving a position in a height direction (z-axis direction) of the display region by the stencil.

[Fig. 20A] Fig. 20A is a view illustrating an example of a first captured image including a display region by a stencil.

[Fig. 20B] Fig. 20B is a view illustrating an example of geometrical relation between an inside of a first image capturing device and a display region

by a stencil.

[Fig. 21] Fig. 21 is a view explaining a modified example of the method of deriving the three-dimensional position of the display region by the stencil.

[Fig. 22] Fig. 22 is a view illustrating an example of steel frames of a structure installed on the ground.

[Fig. 23] Fig. 23 is a view illustrating an example of pipes installed in the ground.

[Fig. 24] Fig. 24 is a view illustrating a second example of the management table.

[Fig. 25] Fig. 25 is a flow chart explaining a second example of processing of the article management device.

[Fig. 26] Fig. 26 is a view illustrating an example of a hardware configuration of the article management device.

DESCRIPTION OF EMBODIMENTS

[0014] Hereinafter, embodiments of the present invention will be described while referring to the drawings.

Note that the description indicating that comparison targets, for example, lengths, positions, sizes, and intervals are the same, includes not only a case where they are strictly the same but also a case where they are differed within a range that does not depart from the gist of the invention (differed within a tolerance range defined when designing, for

example).

[0015] (First embodiment)

First, a first embodiment will be described. The present embodiment exemplifies a case where a position of an article whose position is changed with time and whose position to be placed is changed with time, is managed. Such position management is also called tracking. The tracking means specification of a position of a target object by following it. The present embodiment exemplifies a case where, in a place including a factory that performs various kinds of processing, for example, heat treatment and cutting on various kinds of plates (steel plates, for example) manufactured in a plurality of steel plants, management of positions of the plates is performed. Accordingly, an outline regarding a factory being a target to which the present embodiment is applied, will be described at first.

[0016] <Outline regarding factory>

Fig. 1 is a view explaining an example of a flow of a product in a factory being a target to which the present embodiment is applied.

[0017] In Fig. 1, plates manufactured in a steel plant are loaded into a transport ship. After that, the transport ship gets to a quay close to the factory. The plates are unloaded from the transport ship, and then loaded into a transport vehicle (a truck or the like). When the plates transported by the transport vehicle arrive at the factory, they are

placed in a storage space in the factory. The plates placed in the storage space are subjected to processing, for example, heat treatment and cutting (gas cutting), and then placed in a warehouse. After that, the plates are shipped from the factory to a customer.

[0018] <Conception>

If a position of each plate conveyed in a manner as described above is managed based on an operation of a conveyor, as in the techniques described in Patent Literatures 1 and 2, a range capable of managing a position is limited. Accordingly, the present inventors focused attention on the fact that on a plate, information managed by a manufacturer of the plate is displayed for the purpose of management of actual article (management of positions of respective plates). To manage a display position of such information is equivalent to management of the position of the plate. Further, if it is possible to specify such information managed by the manufacturer of the plate, it is possible to identify the plate. The present embodiment has been made based on such a conception.

[0019] <Display performed on plate>

Fig. 2 is a view illustrating an example of a display region with respect to a plate. Note that an x-axis, a y-axis, and a z-axis illustrated in Fig. 2 indicate a relation between directions in Fig. 2 and directions in later-described Fig. 3A, Fig. 3B, Fig.

14 and Fig. 15, Fig. 18 and Fig. 19, and Fig. 21, and do not always correspond to directions of x-y-z coordinates illustrated in Fig. 4 and Fig. 5. Note that the x-y-z coordinates are, for example, coordinates expressed by a world coordinate system.

In Fig. 2, a display region 201 is a display region by a stencil. In the example illustrated in Fig. 2, the display region 201 by the stencil exists on a plate surface of the plate. Note that a dotted line illustrated in Fig. 2 is a virtual line, and is not actually displayed. In the example illustrated in Fig. 2, a label (side label) 202 is attached to a side surface (plate thickness portion) of the plate.

[0020] Fig. 3A is a view illustrating an example of display contents by a stencil. Note that as described above, the x-y-z coordinates illustrated in Fig. 3A indicate the relation with respect to the directions in Fig. 2 and the like. Further, in the x-y-z coordinates illustrated in Fig. 3A, a symbol indicated by a white circle (○) with a black circle (●) therein indicates a direction from a distant side toward a near side of the paper sheet. Such a notation of the x-y-z coordinates is similarly applied to the other drawings.

In the example illustrated in Fig. 3A, the display by the stencil includes a mark 301, a customer name 302, a standard 303, a size 304, an ID 305, a customer code 306, and an order number 307.

[0021] The mark 301 is a mark representing a

manufacturer of the plate. The customer name 302 is information indicating a customer (buyer) of the plate. The standard 303 is information indicating a standard of the plate. The size 304 is information indicating a size (for example, thickness × width × length) of the plate. The ID 305 is information for uniquely identifying the plate, and is a plate number (an identification number of the plate) in the example illustrated in Fig. 3A. Therefore, the same ID is never given to a different plate. The customer code 306 is information designated to be given to the plate from the customer to the manufacturer of the plate. The order number 307 is a part of a number for identifying the order of the plate from the customer.

[0022] The mark 301, the customer name 302, the standard 303, the size 304, the ID 305, the customer code 306, and the order number 307 are pieces of information capable of being generally displayed on the plate. Note that the pieces of information other than the ID 305 may not be included in the display by the stencil. Further, information other than the above-described pieces of information may be included in the display by the stencil.

[0023] Note that there is a case where a digit number of the customer code 306 is different depending on customers, or a notation method of the standard 303 is different depending on steel plants that manufacture plates, for example. Further, there

is a case where the order number 307 is given, and there is a case where it is not given, depending on customers, for example. Further, a size of the display item is sometimes different depending on steel plants that manufacture the plates. Further, a position of a display region by the stencil is also different in some cases depending on the steel plants that manufacture the plates. As described above, the contents, the position, and the size of the display by the stencil are different depending on the steel plants that manufacture the plates, the customers, and so on.

[0024] The mark 301, the customer name 302, the standard 303, the size 304, the ID 305, the customer code 306, and the order number 307 are pieces of information managed by the manufacturer of the plate. Further, the mark 301, the customer name 302, the standard 303, the size 304, the ID 305, the customer code 306, and the order number 307 are pieces of information capable of being identified by a person. The information capable of being identified by a person indicates one such that when the person sees the information, he/she can understand the meaning of the information. Information that requires encoding and decoding by a machine for creating and reading the information, for example, a barcode and a two-dimensional code, is not the information capable of being identified by a person. Concretely, the mark 301, the customer name 302, the standard 303, the

size 304, the ID 305, the customer code 306, and the order number 307 include at least one of a character, a numeric character, and a symbol as information that does not require decoding by a machine for reading, and do not include information that requires decoding by a machine for reading.

[0025] Fig. 3B is a view illustrating an example of display contents by a label. Note that as described above, the x-y-z coordinates illustrated in Fig. 3B indicate the relation of directions with respect to those in Fig. 2 and the like. Further, in the x-y-z coordinates illustrated in Fig. 3B, a symbol indicated by a white circle with × (cross mark) therein indicates a direction from a near side toward a distant side of the paper sheet. Such a notation of the x-y-z coordinates is similarly applied to the other drawings.

In the example illustrated in Fig. 3B, the display by the label includes a standard 311, an ID 312, a size 313, a delivery date 314, and a customer code 315. The delivery date 314 is information indicating a delivery date of the plate. The standard 311, the ID 312, the size 313, and the customer code 315 are the same as the standard 303, the size 304, the ID 305, and the customer code 306, respectively. Note that the pieces of information other than the ID 312 may not be included in the display by the label. Further, information other than the above-described pieces of information may be

included in the display by the label. The contents, the position, and the size of the display by the label are different depending on the steel plants that manufacture the plates, the customers, and so on, in a similar manner to the display by the stencil.

[0026] However, contents meant by the same display item with respect to the same plate are set to the same between the display by the stencil and the display by the label. Therefore, when the display by the stencil illustrated in Fig. 3A and the display by the label illustrated in Fig 3B are made with respect to the same plate, the ID 305 displayed by the stencil and the ID 312 displayed by the label mean the same contents. Further, the standard 303 displayed by the stencil and the standard 311 displayed on the label mean the same contents. The size 313 and the customer code 315 also mean contents same as those of the size 304 and the customer code 306, respectively. As described above, the standard 303, the ID 305, the size 304, and the customer code 306 are the pieces of information managed by the manufacturer of the plate. Therefore, the standard 311, the ID 312, the size 313, and the customer code 315 are also the pieces of information managed by the manufacturer of the plate. Further, the delivery date 314 of the plate is also the information managed by the manufacturer of the plate. Further, the standard 311, the ID 312, the size 313, the delivery date 314, and the customer code 315 are the pieces of

information capable of being identified by a person.

Note that on the plate, display by a die stamp, for example, is sometimes performed, other than the display as described above. Further, display by handwriting is sometimes performed on the plate.

[0027] <Plate conveyance pattern>

<<Transport by transport ship>>

Fig. 4 is a view illustrating an example of a state in which plates are loaded and unloaded into and from a transport ship. Fig. 4 exemplifies a case where the plates are loaded and unloaded into and from a transport ship 400 by using a gantry crane 410. Fig. 5 is a view in which a state where a plate 420 is lifted by a cargo handling device 411 is seen from an extending direction of a girder 412 (y-axis direction). The x-y-z coordinates illustrated in Fig. 4 and Fig. 5 indicate the relation of directions between Fig. 4 and Fig. 5.

The gantry crane 410 includes the cargo handling device (a trolley or the like) 411, the girder (traversing girder) 412, and a leg structure 413. The cargo handling device 411 moves along the extending direction of the girder 412 (the y-axis direction) in a state of lifting a conveyance target object. Fig. 4 illustrates a state where the plate 420 is moved by being lifted by the cargo handling device 411. Fig. 5 illustrates a state where the plate 420 is lifted by the cargo handling device 411, which is seen from the extending direction of the

girder 412 (the y-axis direction).

[0028] Note that Fig. 4 and Fig. 5 exemplify the state where one plate 420 is lifted by the cargo handling device 411. However, the plate conveyance pattern by the cargo handling device 411 is not limited to such a conveyance pattern. Fig. 6A to Fig. 6E are views illustrating first to fifth examples of the plate conveyance pattern. In Fig. 6A to Fig. 6E, the cargo handling device 411 is illustrated in a further simplified manner.

[0029] Fig. 6A exemplifies a state where two plates are simultaneously conveyed by the cargo handling device 411 in a state of being arranged in a horizontal plane (an x-y plane) direction. Fig. 6B exemplifies a state where one plate is conveyed on a top side (a negative direction side of the x-axis) of the cargo handling device 411. Fig. 6C exemplifies a state where one plate is conveyed on a bottom side (a positive direction side of the x-axis) of the cargo handling device 411. Fig. 6D exemplifies a state where one plate is conveyed at a center of the cargo handling device 411. Fig. 6E exemplifies a state where a plurality of (two) plates are simultaneously conveyed, in a stacked state, by the cargo handling device 411. As above, in the present embodiment, there is a case where a plurality of plates are simultaneously conveyed in a stacked state.

[0030] As described above, the plate conveyance pattern by the cargo handling device 411 is not

limited. Further, a method of lifting the plate by the cargo handling device 411 may employ a method using a magnetic attraction force by a magnet, a method using a hook, and methods other than the above.

The gantry crane 410 itself can be explained by a well-known technique, and thus a detailed explanation thereof will be omitted here.

[0031] Plates manufactured by a steel plant are transported to a quay, and are placed in a predetermined storage space to which they can be conveyed by the gantry crane 410. As illustrated in Fig. 4, there is a case where a plurality of plates are placed in the predetermined storage space in a stacked state. There is also a case where the plates are placed one by one in the predetermined storage space. Further, in Fig. 4 and the like, a case where thicknesses of the plurality of plates (plate thicknesses) are the same is exemplified, for convenience of notation. However, the thicknesses of the plurality of plates are sometimes different. Specifically, there is a case where at least one of a thickness, a width, and a length is different among the plates to be placed in the predetermined storage space.

[0032] Fig. 4 exemplifies a case where a plurality of plates are placed in a stacked manner so that a plate surface of the plate becomes parallel to a surface on which the plate is placed. However, a method of placing the plates in a stacked manner is

not limited to such a method. For example, there is a case where a plurality of plates are placed in a stacked manner so that a plate surface of the plate has an angle perpendicular or nearly perpendicular to a surface on which the plate is placed. The same applies to a position other than the predetermined storage space of the quay.

[0033] In the present embodiment, first image capturing devices 430a to 430f are attached to the girder 412 and the leg structure 413. The number and the position of the first image capturing devices 430a to 430f are set so that as many display regions of the plates as possible are captured as the display region 201 by the stencil and the display region by the label 202 of the plates. Further, also to the cargo handling device 411, first image capturing devices 430g to 430m are attached. The number and the position of the first image capturing devices 430a to 430m are set so that the possibility of capturing at least one of the display region 201 by the stencil and the display region by the label 202 of the plate 420 that is being conveyed by the gantry crane 410, by at least one image capturing device out of the first image capturing devices 430a to 430m, becomes as large as possible.

[0034] The first image capturing devices 430a to 430m can adjust image capturing conditions (an image capturing direction, an angle of view, a zoom magnification, an aperture (F value), and the like).

The adjustment of the image capturing conditions may be performed by an operator (worker) when he/she operates the first image capturing devices, or it may also be automatically performed based on an instruction made by an external device. Further, for example, out of the first image capturing devices 430g to 430m attached to the girder 412, the first image capturing devices 430i to 430m attached at positions close to the plate 420 under conveyance, may be fiberscope cameras. If the fiberscope cameras are used, it is possible to capture the display region 201 by the stencil and the display region by the label 202 of the plate 420 under conveyance, in a closed-up manner, for example.

[0035] Note that the captured image to be captured by the first image capturing device is not limited to a still image, and it may also be a moving image. When the captured image to be captured by the first image capturing device is a moving image, an image taken out from the moving image captured by the first image capturing device (namely, a frame image of the moving image) is used by a later-described article management device 1200. When designing as above, it is preferable to make a still image in which a focus on a subject captured by the first image capturing device is as sharp as possible to be taken out from the moving image captured by the first image capturing device. The captured image captured by the image capturing device is not limited to the still

image as described above, which is also similarly applied to later-described second image capturing device to seventh image capturing device.

[0036] Plates conveyed from a steel plant are placed in a predetermined storage space of the gantry crane 410. A region including the display region 201 by the stencil of each plate placed in the predetermined storage space of the gantry crane 410 is captured by the first image capturing devices 430c to 430f. An operator (worker) operates an information processing terminal in an operation room of the gantry crane 410, or an information processing terminal (a tablet terminal, or the like) held by the operator (worker) of the gantry crane 410, to thereby issue a display instruction of a preview image to each of the first image capturing devices 430c to 430f. Each of the first image capturing devices 430c to 430f transmits, based on the display instruction of the preview image, the preview image to the information processing terminal. Consequently, the preview image is displayed by the information processing terminal. The operator (worker) operates the information processing terminal to issue an image capturing instruction to the first image capturing devices each capturing the preview image in which the display region by the stencil to be photographed is displayed. Upon receiving the image capturing instruction, each of the first image capturing devices 430c to 430f captures a captured image of a region including the

display region 201 by the stencil. Note that the preview image is a live image displayed for confirmation by the operator (worker), and is assumed to be displayed based on the display instruction of the preview image. The captured image is assumed to be an image that is captured based on the image capturing instruction when the preview image is being displayed. Further, although the case where the preview image is displayed is exemplified here, the preview image does not always have to be displayed.

[0037] When a plurality of plates are simultaneously conveyed in a stacked state, a region including the display region 201 by the stencil of a plate at a lower position cannot be captured. In this case, instead of a captured image of the region including the display region 201 by the stencil, a captured image of a region including the display region by the label 202 is captured.

[0038] Depending on a position at which the plate is placed, there is a case where the display region 201 by the stencil and the display region by the label 202 are not included in the image capturing range of each of the first image capturing devices 430c to 430f. In this case, the operator (worker) may operate unmanned aircrafts (drones) 440a and 440b including first image capturing devices, to thereby capture a captured image of a region including the display region 201 by the stencil (or a region including the display region by the label 202) of a

desired plate, by using the first image capturing devices. Further, it is also possible to capture, by using a first image capturing device held by the operator (worker), a captured image of the region including the display region 201 by the stencil (or the region including the display region by the label 202) of the desired plate. Note that the first image capturing device held by the operator (worker) may be, for example, an information terminal device (a tablet terminal, a smartphone, or the like) including the first image capturing device.

[0039] Note that the display of the preview image and the capturing of the captured image by the first image capturing devices 430c to 430f described above, are similarly executed also in the first image capturing devices 430a and 430b, and 430g to 430w, other than the first image capturing devices 430c to 430f. Further, the capturing of the captured image of the region including the display region by the label 202 when the plurality of plates are simultaneously conveyed in a stacked state, is similarly executed also in the first image capturing devices 430a and 430b, and 430g to 430w, other than the first image capturing devices 430c to 430f. Further, an image capturing method when the display region 201 by the stencil and the display region by the label 202 are not included in the image capturing range of each of the first image capturing devices 430c to 430f, is the same also in the first image

capturing devices 430a and 430b, and 430g to 430w, other than the first image capturing devices 430c to 430f. Therefore, a detailed explanation thereof regarding the first image capturing devices 430a and 430b, and 430g to 430w, other than the first image capturing devices 430c to 430f will be omitted hereinbelow.

[0040] The plates are placed in a predetermined storage space of the gantry crane 410, and then loaded into the transport ship 400 by the gantry crane 410. There is a case where a plurality of plates are simultaneously loaded into the transport ship 400 in a stacked state. There is also a case where the plates are loaded one by one into the transport ship 400. Further, there is a case where at least one of a thickness, a width, and a length is different among the plates to be loaded into the transport ship 400.

[0041] A captured image of a region including the display region 201 by the stencil of each plate that is being conveyed by the gantry crane 410, is captured by the first image capturing devices 430g to 430m attached to the cargo handling device 411.

[0042] After each plate is loaded into the transport ship 400, a captured image of a region including the display region 201 by the stencil of the plate is captured by the first image capturing devices 430a and 430b attached to the girder 412, or a first image capturing device 430n attached to the transport ship

400. The first image capturing device 430n attached to the transport ship 400 can also adjust the image capturing conditions (the image capturing direction, the angle of view, the zoom magnification, the aperture (F value), and the like), in a similar manner to the first image capturing devices 430a to 430m. Note that in Fig. 4, the number of the first image capturing device that is attached to the transport ship 400 is set to one, for convenience of notation. However, to the transport ship 400, a plurality of first image capturing devices are attached so that a region in which the plate is placed is included in the image capturing range.

[0043] The transport ship 400 after loading the plates thereinto as described above, gets to a quay close to a factory. The plates are unloaded from the transport ship 400 as described above. As described above, in the present embodiment, the plates are unloaded by using the gantry crane 410. Regarding the plate that is being conveyed by the gantry crane 410, a captured image is captured similarly to the case where the plate is loaded into the transport ship 400. Further, when the plate is unloaded by the gantry crane 410 and placed in a predetermined storage space of the gantry crane 410, a captured image of the plate is also captured in a similar manner to the case where the plate is conveyed from the steel plant and then placed in the predetermined storage space of the gantry crane 410.

[0044] <<Transport by transport vehicle>>

The plates placed in the predetermined storage space of the gantry crane 410 are loaded into a transport vehicle. Fig. 7 is a view illustrating an example of a state in which the plates are loaded and unloaded into and from the transport vehicle. The plates placed in the predetermined storage space of the gantry crane 410 are loaded into a transport vehicle 700 by using a not-illustrated crane, or the like. As illustrated in Fig. 7, there is a case where a plurality of plates are simultaneously loaded into the transport vehicle 700 in a stacked state. However, there is also a case where the plates are loaded one by one into the transport vehicle 700. Further, there is a case where at least one of a thickness, a width, and a length is different among the plates to be loaded into the transport vehicle 700. Further, the plates may also be loaded into the transport vehicle 700 by being conveyed in a manner as illustrated in Fig. 6A to Fig. 6E.

[0045] Fig. 8 is a view illustrating an example of a state where the plates were loaded into the transport vehicle 700. First image capturing devices 430o and 430p are attached to a structure installed at a standby position of the transport vehicle 700. The number and the position of the first image capturing devices 430o and 430p are set so that as many display regions of the plates as possible are captured as the display region 201 by the stencil and the display

region by the label 202 of the plates loaded into the transport vehicle 700. Further, also to the transport vehicle 700, a first image capturing device 430q is attached. The first image capturing devices 430o to 430q can also adjust the image capturing conditions (the image capturing direction, the angle of view, the zoom magnification, the aperture (F value), and the like), similarly to the first image capturing devices 430a to 430m.

[0046] A region including the display region 201 by the stencil of each plate loaded into the transport vehicle 700 is captured by the first image capturing devices 430o to 430q.

[0047] <<Conveyance in factory>>

When the transport vehicle 700 after loading the plates thereinto as described above arrives at a factory, the plates are unloaded from the transport vehicle 700. The plates loaded into the transport vehicle 700 are unloaded from the transport vehicle 700 by using a not-illustrated crane or the like. As illustrated in Fig. 7, there is a case where a plurality of plates are simultaneously unloaded from the transport vehicle 700 in a stacked state. However, there is also a case where the plates are unloaded one by one from the transport vehicle 700. Further, there is a case where at least one of a thickness, a width, and a length is different among the plates to be unloaded from the transport vehicle 700. Further, the plates may also be unloaded from

the transport vehicle 700 by being conveyed in a manner as illustrated in Fig. 6A to Fig. 6E. Note that the conveyor used for conveying the plates from the transport ship 400 to the predetermined storage space of the gantry crane 410 (the gantry crane 410) and the conveyor used for conveying the plates from the transport vehicle 700 to the storage space in the factory (the not-illustrated crane or the like) are different conveyors. In a manner as above, plates conveyed to a certain storage space by a certain conveyor are sometimes conveyed by another conveyor different from the certain conveyor to another storage space to which they cannot be conveyed by the certain conveyor. This similarly applies to a case where plates are conveyed between other storage spaces, for example, respective storage spaces in the factory.

[0048] Fig. 9A to Fig. 9C are views illustrating first to third examples of a state of plates placed in a storage space in a factory. To a structure installed in the storage space in the factory, first image capturing devices 430r to 430w are attached. As illustrated in Fig. 9A to Fig. 9C, the plates are placed in various patterns in the storage space in the factory. Accordingly, the number and the position of the first image capturing devices 430r to 430w are set so that as many display regions of the plates as possible are captured as the display region 201 by the stencil and the display region by the

label 202 of the plates placed in the storage space. The first image capturing devices 430r to 430w can also adjust the image capturing conditions (the image capturing direction, the angle of view, the zoom magnification, the aperture (F value), and the like), similarly to the first image capturing devices 430a to 430m.

[0049] A region including the display region 201 by the stencil of each plate placed in the storage space in the factory is captured by the first image capturing devices 430r to 430w.

[0050] When each plate is placed in a storage space for stock, a region including the display region 201 by the stencil (or the display region by the label 202) of the plate is captured by the first image capturing devices 430r to 430w, as described above.

[0051] After that, the plates are conveyed to a production facility. Fig. 10 is a view illustrating an example of a state where the plates are processed in the production facility. In Fig. 10, a production facility 1000 is, for example, a facility for performing heat treatment and a facility for performing gas cutting. Fig. 10 exemplifies a case where conveyor rolls 1001 are used to convey plates 1002a and 1002b. Note that conveyance of the plates between the storage space and the conveyor rolls 1001 is realized by using a not-illustrated conveying device or the like.

[0052] To a structure installed in a production line

in the factory, first image capturing devices 430x and 430y are attached. The number and the position of the first image capturing devices 430x and 430y are set so that the display region 201 by the stencil of each of the plates 1002a and 1002b is captured. The first image capturing devices 430x and 430y can also adjust the image capturing conditions (the image capturing direction, the angle of view, the zoom magnification, the aperture (F value), and the like), similarly to the first image capturing devices 430a to 430m. Note that it is assumed that the plates 1002a and 1002b conveyed on the conveyor rolls 1001 are never stacked. Further, a conveyance route of the plates 1002a and 1002b on the conveyor rolls 1001 can be supposed beforehand. For this reason, in the present embodiment, it is assumed that there is no chance that the display region by the label 202 of each of the plates 1002a and 1002b is not captured by the first image capturing devices 430x and 430y. Note that the display region by the label 202 of each of the plates 1002a and 1002b may be captured by using an unmanned aircraft provided with a first image capturing device. Note that in Fig. 10, a dotted line indicates the conveyance route of the plates 1002a and 1002b on the conveyor rolls 1001, and does not actually exist.

[0053] The plate 1002a conveyed from the storage space in the factory is placed on the conveyor rolls 1001, and conveyed by the conveyor rolls 1001. A

region including the display region 201 by the stencil of the plate 1002a that is being conveyed on the conveyor rolls 1001 before entering the production facility 1000, is captured by the first image capturing device 430x. Further, a region including the display region 201 by the stencil of the plate 1002b that is being conveyed on the conveyor rolls 1001 after coming out of the production facility 1000 after being subjected to the processing in the production facility 1000, is captured by the first image capturing device 430y.

[0054] After that, the plates are placed in the storage space as exemplified in Fig. 9A to Fig. 9C in the warehouse. As described above, the region including the display region 201 by the stencil (or the display region by the label 202) of each plate placed in the storage space in the factory is captured by the first image capturing devices 430r to 430w. At the shipment, the plates are moved from the warehouse to a storage space for shipment. The region including the display region 201 by the stencil (or the display region by the label 202) of each plate placed in the storage space for shipment is captured by the first image capturing devices 430r to 430w.

[0055] Also in the respective storage spaces in the factory, a plurality of plates are sometimes placed in a stacked state. There is also a case where the plates are placed one by one in the respective

storage spaces in the factory. Further, there is a case where at least one of a thickness, a width, and a length is different among the plates to be placed in the respective storage spaces in the factory.

[0056] Fig. 11 is a view illustrating an example of an original plate and plates after being cut. Fig. 11 exemplifies a case where a plate 1100 is cut, to thereby manufacture plates 1110, 1120, 1130, and 1140. After the plates 1110, 1120, 1130, and 1140 are manufactured as described above, display is performed on each of the plates 1110, 1120, 1130, and 1140. Fig. 11 illustrates display regions 1111, 1121, 1131, and 1141 with respect to the plates 1110, 1120, 1130, and 1140. On the display regions 1111, 1121, 1131, and 1141, pieces of information including IDs of the plates 1110, 1120, 1130, and 1140 are displayed. On the display regions 1111, 1121, 1131, and 1141, a display by a stencil, for example, is performed. It is also possible to perform, in addition to the display by the stencil, at least one of a display by a die stamp and a display by a label. Further, the display on the display regions 1111, 1121, 1131, and 1141 may also be performed by handwriting.

[0057] Further, an ID of the original plate 1100 may also be displayed on the display regions 1111, 1121, 1131, and 1141. On the display regions 1111, 1121, 1131, and 1141, the display by the stencil, for example, is performed. However, the display on the display regions 1111, 1121, 1131, and 1141 may also

be performed by handwriting. This similarly applies to the display with respect to the display region 201 and the display by the label 202. Hereinafter, the display regions 1111, 1121, 1131, and 1141 are assumed to be display regions by the stencil.

[0058] When the plates 1110, 1120, 1130, and 1140 are manufactured, it is possible to capture a captured image of a region including the display regions 1111, 1121, 1131, and 1141 by the stencil of desired plates, by using a first image capturing device held by an operator (worker), for example. Note that the first image capturing device held by the operator (worker) may be, for example, an information terminal device (a tablet terminal, a smartphone, or the like) provided with the first image capturing device. Further, the operator (worker) may operate an unmanned aircraft provided with the first image capturing device, to thereby capture a captured image of the region including the display regions 1111, 1121, 1131, and 1141 by the stencil of the desired plates by using the first image capturing device.

[0059] As described above, the present embodiment exemplifies the case in which at least when the plates are placed in the transport ship 400, when the plates are unloaded from the transport ship 400 and loaded into the transport vehicle 700, and when the plates are placed in the respective storage spaces of the gantry crane 410 and the factory, the captured

image of the region including the display region 201, 1111, 1121, 1131, or 1141 by the stencil and the display region by the label 202 of each of the plates can be obtained.

[0060] In the present embodiment, the captured image captured as described above is used to automatically specify a position of a plate by using an article management device. Note that when plates are conveyed one by one, the display region 201 by the stencil can be captured, and thus the captured image of the region including the display region by the label 202 becomes unnecessary. In the following explanation, when the display by the stencil and the display by the label 202 are named generically, the generic name will be described as the display by the stencil (label), according to need. Further, when the display regions 201, 1111, 1121, 1131, and 1141 by the stencil, and the display region by the label 202 are named generically, the generic name will be described as the display region by the stencil (label), according to need.

[0061] <Article management device>

Fig. 12 is a view illustrating an example of a functional configuration of an article management device 1200. Hardware of the article management device 1200 is realized by using, for example, an information processing device including a CPU, a ROM, a RAM, a HDD, and various interfaces, or dedicated hardware. Fig. 13 is a view illustrating an example

of a management table 1300 managed by the article management device 1200. Note that as described above, in the present embodiment, the tracking is performed by the article management device 1200. Therefore, in the present embodiment, the article management device 1200 corresponds to a tracking device.

[0062] As illustrated in Fig. 12, in the present embodiment, the article management device 1200 includes a first image acquisition unit 1201, a recognition unit 1202, an obtainment unit 1203, a collation unit 1204, a specification unit 1205, a position derivation unit 1206, a storage unit 1207, an output unit 1208, and a second image acquisition unit 1209.

[0063] The first image acquisition unit 1201 acquires a first captured image of a region including a display region by a stencil (label). The recognition unit 1202 recognizes, from the first captured image acquired by the first image acquisition unit 1201, components, positions, and the like of display items in the display by the stencil (label). The obtainment unit 1203 obtains information stored in a section of ID in a section of actual article display in a later-described management table 1300. The collation unit 1204 collates the information recognized by the recognition unit 1202 with the information obtained by the obtainment unit 1203. The specification unit 1205 specifies, based on the result of collation

performed by the collation unit 1204, one plate out of plates managed in the management table 1300. In the present embodiment, an identification information acquisition unit 1210 that acquires identification information of a plate includes the recognition unit 1202, the obtainment unit 1203, the collation unit 1204, and the specification unit 1205. The position derivation unit 1206 derives x-y-z coordinates (three-dimensional coordinates) of the display region by the stencil (label), as a three-dimensional position of the plate specified by the specification unit 1205. The storage unit 1207 stores the information indicating the three-dimensional position of the plate, in the management table 1300. The output unit 1208 outputs the information indicating the three-dimensional position of the plate. The second image acquisition unit 1209 acquires a second captured image for specifying a position in a height direction (z-axis direction) of the display region by the stencil (label) in the position derivation unit 1206. An example of details of the article management device 1200 will be described later while referring to a flow chart in Fig. 17.

[0064] In the management table 1300 in Fig. 13, information used for managing a position of a plate by the article management device 1200 is stored. The information stored in the management table 1300 includes information managed by a manufacturer of plates. However, a part of the information stored in

the management table 1300 may be information that can be utilized also in distribution and the like. Here, the information managed by the manufacturer of the plates, is information set or acquired by the manufacturer of the plates. The information managed by the manufacturer of the plates includes information whose meaning can be understood by an operator being an employee of the manufacturer of the plates. More concretely, the information managed by the manufacturer of the plates is, for example, information created by the manufacturer of the plates and stored in the management table 1300. In the present embodiment, the information stored in the management table 1300 is an example of article management data, and by storing respective pieces of information in the management table 1300, an example of a data structure of the article management data is realized.

[0065] In Fig. 13, information on the same column corresponds to identification information with respect to the same plate (sections below the same No. are sections in which pieces of identification information with respect to the same plate are respectively stored).

In Fig. 13, in the section of actual article display, information regarding respective display items of the display by the stencil (label) is stored. In a section of non-actual article display, information other than the information regarding the

respective display items of the display by the stencil (label) is stored. In the present embodiment, the information stored in the section of actual article display is an example of display information included in the article management data, and the information stored in the section of non-actual article display is an example of non-display information included in the article management data.

[0066] An example of information stored in the section of actual article display in the management table 1300 will be described.

In a section of stencil in the section of actual article display, information regarding the stencil is stored.

In a section of ID in the section of stencil, information indicating contents and positions of components of the ID 305 included in the display by the stencil is stored. Note that the components indicate individual pieces of information configuring the display items, for example, characters, numeric characters, symbols, and marks.

In a section of customer name in the section of stencil, information indicating contents and positions of components of the customer name 302 included in the display by the stencil is stored.

[0067] In a section of size in the section of stencil, information indicating contents and positions of components of the size 304 included in the display by the stencil is stored.

In a section of standard in the section of stencil, information indicating contents and positions of components of the standard 303 included in the display by the stencil is stored.

In a section of customer code in the section of stencil, information indicating contents and positions of components of the customer code 306 included in the display by the stencil is stored.

[0068] In a section of order number in the section of stencil, information indicating contents and positions of components of the order number 307 included in the display by the stencil is stored.

Other than the above-described display items in the display by the stencil, contents of display items that may be displayed as the display items of the display by the stencil are also stored in the management table 1300. This is indicated by "···" below a section of additional information in the section of stencil in Fig. 13. Further, the display item itself may be added and/or deleted.

[0069] In a section of label in the section of actual article display, information regarding the label is stored.

In a section of ID in the section of label, information indicating contents and positions of components of the ID 312 included in the display by the label is stored.

In a section of size in the section of label, information indicating contents and positions of

components of the size 313 included in the display by the label is stored.

[0070] In a section of standard in the section of label, information indicating contents and positions of components of the standard 311 included in the display by the label is stored.

In a section of delivery date in the section of label, information indicating contents and positions of components of the delivery date 314 included in the display by the label is stored.

In a section of customer code in the section of label, information indicating contents and positions of components of the customer code 315 included in the display by the label is stored.

[0071] Other than the above-described display items in the display by the label, contents of display items that may be displayed as the display items of the display by the label are also stored in the management table 1300. This is indicated by "···" below the section of customer code in the section of label in Fig. 13. Further, the display item itself may be added and/or deleted.

[0072] Next, an example of information stored in a section of non-actual article display in the management table 1300 will be described.

In a section of position in article, information indicating a position of a display region in a case where a predetermined position in a plate is set to an origin (reference) is stored.

In a section of stencil in the section of position in article, information indicating a position of the display region by the stencil in a case where the predetermined position in the plate is set to the origin (reference) is stored.

In a section of label in the section of position in article, information indicating a position of the display region by the label in a case where the predetermined position in the plate is set to the origin (reference) is stored.

[0073] In a section of article position, information indicating a three-dimensional position of the plate is stored. The information stored in the section of article position is information indicating the three-dimensional position of the plate specified by the article management device 1200. Therefore, regarding the three-dimensional position of the same plate specified by the article management device 1200, not only the x-coordinate and the y-coordinate but also the z-coordinate changes in some cases according to the movement of the plate. Accordingly, regarding a three-dimensional position of the information display position of the same plate specified by the article management device 1200 as well, not only the x-coordinate and the y-coordinate (a position in a horizontal plane direction) but also the z-coordinate (a position in a height direction) changes in some cases according to the movement of the plate.

[0074] In a section of registration time,

information indicating date and time (a timing defined by date and time) at which the plate was placed at the current position is stored.

[0075] In a section of parent ID, information indicating an ID of an original plate is stored. The plate is sometimes cut in the factory. The original plate indicates the plate before being cut. Therefore, when the information indicating the ID of the original plate is stored in the section of parent ID, pieces of information stored in sections on the same column including the section of parent ID in which the information indicating the ID of the original plate is stored, become pieces of information with respect to the cut plate. When the plates 1110, 1120, 1130, and 1140 are manufactured as illustrated in Fig. 11, in the section of actual article display with respect to the plates 1110, 1120, 1130, and 1140 in the management table 1300, pieces of information indicating contents and positions of components of display items displayed on the display regions 1111, 1121, 1131, and 1141 are stored. Further, in the section of parent ID with respect to the plates 1110, 1120, 1130, and 1140, information indicating an ID of the plate 1100 is stored. As above, the present embodiment exemplifies a case where the pieces of information of the cut plates are managed as new columns (No) in the management table 1300 illustrated in Fig. 13. In the management table 1300, the pieces of information with respect to the

cut plates are stored in the sections of actual article display and non-actual article display.

[0076] Here, for example, there is a case where the plate 1110 is cut to further manufacture a plurality of different plates. In this case, in the section of parent ID with respect to the plurality of different plates, information indicating an ID of the plate 1110 is stored. In the section of parent ID with respect to the plate 1110, the information indicating the ID of the plate 1100 is stored. As above, by tracing the information stored in the section of parent ID, it is possible to specify a transition of each plate. A line of plates capable of being obtained by tracing the information stored in the section of parent ID regarding a certain plate as described above, will be called a cut plate series of the plate. For example, the cut plate series of the plate 1110 includes the plates 1100 and 1110. Further, in the section of parent ID of each plate, not only information indicating the latest plate ID but also information indicating IDs of all the plates that belong to the cut plate series may also be stored, so that the cut plate series of each plate can be confirmed, for example. In this case, as each ID, one defined by a manufacturer is used.

[0077] In a section of carrier ID, an ID of a carrier of the plate is stored. The present embodiment exemplifies a case where the carrier is the transport ship 400 and the transport vehicle 700.

When a plate is loaded into the transport ship 400, the article management device 1200 may store information indicating an ID of the transport ship 400 in the following manner, for example.

First, the article management device 1200 acquires an ID of the plate and an ID (namely, a ship number) of the transport ship 400. Further, the article management device 1200 specifies, from the section of ID in the management table 1300, a column on which information indicating an ID same as the acquired ID of the plate is stored. Subsequently, the article management device 1200 stores information indicating the acquired ID of the transport ship 400, in the section of carrier ID on the specified column.

[0078] For example, it is possible that the first image capturing devices 430a, 430b, and 430n are used to capture a captured image including the display region 201 by the stencil or the display region by the label 202, and a region in which the information indicating the ID of the transport ship 400 is displayed. In such a case, the article management device 1200 may also recognize and acquire the ID of the plate and the ID of the transport ship 400 from the captured image.

[0079] Further, it is also possible that the first image capturing devices 430a, 430b, and 430n are used to capture a captured image including the display region 201 by the stencil or the display region by the label 202, and a captured image including the

region in which the information indicating the ID of the transport ship 400 is displayed. For example, it is possible to design such that the captured image including the region in which the information indicating the ID of the transport ship 400 is displayed is captured after the capturing of the captured image including the display region 201 by the stencil or the display region by the label 202. In such a case, the article management device 1200 may also acquire the ID recognized from the captured image including the display region 201 by the stencil or the display region by the label 202, and the ID recognized from the captured image including the region in which the information indicating the ID of the transport ship 400 is displayed, as the ID of the plate and the ID of the transport ship 400, respectively.

[0080] Further, for example, the operator (worker) of the transport ship 400 may input the ID of the plate and the ID of the transport ship 400 in an information processing terminal (a tablet terminal or the like) held by the operator (worker). In such a case, it is possible to transmit the ID of the plate and the ID of the transport ship 400 from the information processing terminal to the article management device 1200, to thereby make the article management device 1200 acquire the ID of the plate and the ID of the transport ship 400.

[0081] Further, when the plate is loaded into the

transport vehicle 700, the article management device 1200 may store information indicating an ID of the transport vehicle 700 in the following manner, for example.

First, the article management device 1200 acquires an ID of the plate and an ID (information of a car registration plate, for example) of the transport vehicle 700. Further, the article management device 1200 specifies, from the section of ID in the management table 1300, a column on which information indicating an ID same as the acquired ID of the plate is stored. Subsequently, the article management device 1200 stores information indicating the acquired ID of the transport vehicle 700, in the section of carrier ID on the specified column.

[0082] For example, it is possible that the first image capturing devices 430o to 430q are used to capture a captured image including the display region 201 by the stencil or the display region by the label 202, and a region in which the information indicating the ID of the transport vehicle 700 is displayed. In such a case, the article management device 1200 may also recognize and acquire the ID of the plate and the ID of the transport vehicle 700 from the captured image.

[0083] Further, it is also possible that the first image capturing devices 430o to 430q are used to capture a captured image including the display region 201 by the stencil or the display region by the label

202, and a captured image including the region in which the information indicating the ID of the transport vehicle 700 is displayed. For example, it is possible to design such that the captured image including the region in which the information indicating the ID of the transport vehicle 700 is displayed is captured after the capturing of the captured image including the display region 201 by the stencil or the display region by the label 202. In such a case, the article management device 1200 may also acquire the ID recognized from the captured image including the display region 201 by the stencil or the display region by the label 202, and the ID recognized from the captured image including the region in which the information indicating the ID of the transport vehicle 700 is displayed, as the ID of the plate and the ID of the transport vehicle 700, respectively.

[0084] Further, for example, the operator (worker) of the transport vehicle 700 may input the ID of the plate and the ID of the transport vehicle 700 in an information processing terminal (a tablet terminal or the like) held by the operator (worker). In such a case, it is possible to transmit the ID of the plate and the ID of the transport vehicle 700 from the information processing terminal to the article management device 1200, to thereby make the article management device 1200 acquire the ID of the plate and the ID of the transport vehicle 700.

[0085] A data structure of the management table 1300 may be a data structure in which information (the article position and the registration time, for example) stored in each section in the management table 1300 is updated every time a plate is placed at a new position. Further, the data structure of the management table 1300 may also be a data structure to which information is to be added. The latter case has an advantage that it is possible to follow a history of an article position.

[0086] Next, an example of contents stored in the section of actual article display and contents stored in the section of position in article in the section of non-actual article display in the management table 1300, will be described more concretely.

Fig. 14 is a view illustrating an example of a position in article of a stencil, and positions of components of respective display items in a display by the stencil. Fig. 14 exemplifies a case where the display by the stencil is performed based on the display position illustrated in Fig. 2 and the contents illustrated in Fig. 3A.

In Fig. 14, by x-y coordinates in which a vertex 203 illustrated in Fig. 2 out of eight vertices of a plate having a rectangular parallelepiped shape is set to an origin, a direction along a width direction of the plate from the vertex 203 is set to a positive direction of the y-axis, and a direction along a length direction of the plate from the vertex 203 is

set to a positive direction of the x-axis, the position in article of the stencil and the positions of the components of the respective display items by the stencil are expressed.

[0087] In the present embodiment, x-y coordinates of two vertices on a diagonal line, out of four vertices of a circumscribed rectangle defined by positions having a maximum value of the x-axis, a minimum value of the x-axis, a maximum value of the y-axis, and a minimum value of the y-axis, out of positions of the components of the respective display items in the display by the stencil, are set to the position in article of the stencil. Fig. 14 indicates that x-y coordinates (Ls10, Ws10) and (Ls11, Ws11) of two vertices 1401a and 1401b of a circumscribed rectangle correspond to the position in article of the stencil. Note that in this case, the circumscribed rectangle is set to a rectangle parallel to coordinate axes (the x-axis and the y-axis in the example illustrated in Fig. 14) that express the position in article, for simplifying the explanation.

[0088] Further, x-y coordinates of a position of a barycenter (or centroid) of each of the components (characters, numeric characters, symbols, and marks) of the respective display items in the display by the stencil are set to a position of each of the components. Fig. 14 indicates that the y-axis coordinates of 5, 6, 3, 4, 9, 7, -, 0, and 1 being components of the ID 305 included in the display by

the stencil are Ws1, Ws2, Ws3, Ws4, Ws5, Ws6, Ws7, Ws8, and Ws9, respectively, and the x-axis coordinate of each of the components is Ls1.

As above, the positions of the respective components of the respective display items in the display by the stencil are expressed by the x-y coordinates.

[0089] Fig. 15 is a view illustrating an example of a position in article of a label, and positions of components of respective display items in a display by the label. Fig. 15 exemplifies a case where the display by the label is performed based on the display position illustrated in Fig. 2 and the display contents illustrated in Fig. 3B.

In Fig. 15, by y-z coordinates in which a vertex 204 illustrated in Fig. 2 out of eight vertices of a plate having a rectangular parallelepiped shape is set to an origin, a direction along a width direction of the plate from the vertex 204 is set to a positive direction of the y-axis, and a direction along a plate thickness direction of the plate from the vertex 204 is set to a positive direction of the z-axis, the position in article of the label and the positions of the components of the respective display items by the label are expressed.

[0090] In the present embodiment, the label is assumed to have a rectangular shape. The y-z coordinates of two vertices on a diagonal line out of four vertices of the label, are set to the position

in article of the label. Further, the y-z coordinates of a position of a barycenter (or centroid) of each of the components of the respective display items in the display by the label are set to a position of each of the components. Fig. 15 indicates that the y-z coordinates of two vertices 1501a and 1501b of the label correspond to the position in article of the label.

[0091] As described above, in the section of ID in the section of stencil in the section of actual article display in the management table 1300 illustrated in Fig. 13, the information indicating the contents and the positions of the components of the ID 305 included in the display by the stencil is stored. Therefore, as illustrated in Fig. 16A, in the example illustrated in Fig. 14, "5", "6", "3", "4", "9", "7", "-", "0", and "1" are stored in the section of ID in the section of stencil in the section of actual article display, as the contents of the components of the ID 305 included in the display by the stencil. Further, in the section of ID in the section of stencil in the section of actual article display, (Ls1, Ws1), (Ls2, Ws1), (Ls3, Ws1), (Ls4, Ws1), (Ls5, Ws1), (Ls6, Ws1), (Ls7, Ws1), (Ls8, Ws1), and (Ls9, Ws1) are stored as the positions of the components.

[0092] Also in the section of another display item in the section of actual article display, information indicating the contents and the positions of the

components of the display item is stored, in a similar manner to the section of ID in the section of stencil. Note that the information indicating the positions of the components of the respective display items in the section of label is expressed by not the x-y coordinates but the y-z coordinates.

[0093] Further, as illustrated in Fig. 16B, in the example illustrated in Fig. 14, (Ls10, Ws10) and (Ls11, Ws11) are stored in the section of stencil in the section of position in article in the section of non-actual article display, as the information indicating the position in article of the stencil.

Also in the section of label in the section of position in article, information indicating the position in article of the label is stored, in a similar manner to the section of stencil in the section of position in article. Note that the information indicating the position in article of the label is expressed by not the x-y coordinates but the y-z coordinates, as described above.

[0094] When creating the management table 1300, for example, the operator may operate a user interface of the article management device 1200 to input, in the article management device 1200, information to be stored in each section in the management table 1300. Further, the article management device 1200 may also receive the information to be stored in each section in the management table 1300, from an external device, for example, a computer that controls an operation of

a factory.

[0095] The information stored in the section of actual article display, and the pieces of information stored in the sections of position in article and parent ID in the section of non-actual article display in the management table 1300, are sometimes defined after performing the display with respect to the plate, and are sometimes defined before performing the display with respect to the plate. Therefore, when the pieces of information to be stored in the sections are defined before performing the display with respect to the plate, the article management device 1200 acquires the pieces of information to be stored in the sections in a manner as described above, for example, and stores the pieces of information in the respective sections in the management table 1300.

[0096] On the other hand, the pieces of information stored in the sections of article position and registration time in the section of non-actual article display, sometimes cannot be defined before performing the display with respect to the plate. Therefore, at a timing where the pieces of information to be stored in the sections were obtained, for example, the article management device 1200 acquires the pieces of information to be stored in the sections and stores the pieces of information in the respective sections in the management table 1300. As described above, in the section of

registration time, the date and time at which the information stored in the section of article position was changed, are stored. In this case, date and time at which the plate was placed at the current position are registered in the section of registration time.

[0097] Note that regarding an item of the section of non-actual article display, information is stored in the section of the item only when the information of the item is already acquired, and when the information of the item is not acquired, the information is not stored in the section of the item. Further, when the information stored in the section of article position is not updated even after passage of predetermined time from the date and time stored in the section of registration time, the article management device 1200 preferably judges that the specification of the position of the plate is stopped, and resets the pieces of information stored in the sections of article position and registration time. Further, at the same position, the plate whose date and time stored in the section of registration time are early, is never conveyed earlier than the plate whose date and time stored in the section of registration time are late (namely, when the plates are stacked, the lower plate never disappears suddenly). For this reason, the article management device 1200 preferably carries out the reset of the pieces of information stored in the sections of article position and registration time, in the

following manner. Specifically, when there is a plate being a plate whose date and time stored in the section of registration time are later than the date and time stored in the section of registration time to be reset, and whose three-dimensional position is the same as the three-dimensional position stored in the section of article position to be reset, it is desirable that the article management device 1200 gives a signal for confirmation by an alarm or the like.

[0098] Next, an example of functions of the article management device 1200 will be described. Fig. 17 is a flow chart explaining an example of processing of the article management device 1200 of the present embodiment. An example of the functions of the article management device 1200 will be described while referring to Fig. 17. Note that in the present embodiment, the tracking is performed by the article management device 1200, as described above. Therefore, in the present embodiment, an article management method realized by using a flow chart exemplified in Fig. 17 corresponds to a tracking method.

[0099] In step S1701 in Fig. 17, the first image acquisition unit 1201 acquires a first captured image. The first captured image is a captured image captured by any one of the first image capturing devices out of the first image capturing devices 430a to 430y, the first image capturing devices provided to the

unmanned aircrafts 440a to 440c, and the first image capturing device held by the operator (worker). The first captured image may be directly transmitted from the first image capturing device to the article management device 1200, or it may also be transmitted from the first image capturing device to the article management device 1200 via an information terminal device. The processing according to the flow chart in Fig. 17 is carried out every time the captured image captured by any one of the image capturing devices out of the first image capturing devices 430a to 430y, the first image capturing devices provided to the unmanned aircrafts 440a to 440c, and the first image capturing device held by the operator (worker), is received by the article management device 1200. In the present embodiment, it is assumed that an ID of the first image capturing device that captured the first captured image, and image capturing conditions at the time of capturing the first captured image, are transmitted together with the first captured image.

[0100] The first image acquisition unit 1201 acquires the ID of the first image capturing device that captured the first captured image, the image capturing conditions at the time of capturing the first captured image, and the date and time of capturing the first captured image, together with the first captured image. The image capturing conditions include information required for specifying a

position of the display region by the stencil or the display region by the label in a manner to be described later, out of pieces of information set in the image capturing device when capturing the image.

[0101] Further, in a case where a position of the first image capturing device when it captured the first captured image is not fixed, positional information of the first image capturing device when it captured the first captured image is transmitted together with the first captured image. If, for example, the unmanned aircrafts 440a to 440c can measure their three-dimensional coordinates (x-y-z coordinates) by using GPS (Global Positioning System), the three-dimensional coordinates may be transmitted as positional information of the first image capturing devices provided to the unmanned aircrafts. Regarding the first image capturing device 430n attached to the transport ship 400, the first image capturing devices 430g to 430m attached to the cargo handling device 411, and the first image capturing device 430q attached to the transport vehicle 700 as well, positional information of each of the first image capturing devices may be transmitted together with the first captured image, in a similar manner to the unmanned aircrafts 440a to 440c. The same applies to the first image capturing device held by the operator (worker).

Note that when the first image capturing device cannot capture a region which should be included in

the first captured image, the image capturing conditions (the image capturing direction, the angle of view, the zoom magnification, the aperture (F value), and the like) of the first image capturing device are adjusted in advance of the processing in step S1701.

[0102] Next, in step S1702, the recognition unit 1202 recognizes, from the first captured image acquired in step S1701, components (characters, numeric characters, symbols, marks) of the display items in the display by the stencil (label). The processing of recognizing contents of the components of the display items can be realized by a technique using well-known OCR (Optical character recognition), for example, and thus a detailed explanation thereof will be omitted here. Note that the processing in step S1702 may also be realized by using a technique that uses AI (Artificial Intelligence), for example, NN (Neural Network), or a technique in which the AI and the OCR are combined (so-called AI OCR).

[0103] Further, the recognition unit 1202 specifies whether the components of the display items are of either the display by the stencil or the display by the label. For example, the recognition unit 1202 performs edge detection processing to detect edges of a plate based on the first captured image acquired in step S1701, and specifies a region of the plate based on the detection result. Subsequently, the recognition unit 1202 determines whether the

specified region is either a plate surface portion of the plate or a side surface (plate thickness) portion of the plate. This determination is realized based on an aspect ratio of the specified region, for example. When, as a result of this determination, the specified region is the plate surface portion of the plate, the recognition unit 1202 recognizes that the components of the display items are of the display by the stencil. On the other hand, when the specified region is the side surface (plate thickness) portion of the plate, the recognition unit 1202 recognizes that the components of the display items are of the display by the label.

[0104] Further, it is also possible that the recognition unit 1202 performs the edge detection processing based on the first captured image, and when a region of the label 202 having a rectangular shape is detected, it recognizes that the components of the display items are of the display by the label, and in the other cases, it recognizes that the components of the display items are of the display by the stencil.

Note that in the present embodiment, regarding a plate at the uppermost position, the first captured image is assumed to include, not the display region by the label 202, but the display region 201 by the stencil, for simplifying the explanation.

[0105] Further, the recognition unit 1202 derives positions of the display items. An example of a

method in which the first recognition unit 1202 derives the positions of the display items, will be described. First, the recognition unit 1202 performs the edge detection processing based on the first captured image acquired in step S1701, to thereby detect the edges of the plate. Subsequently, the recognition unit 1202 detects an origin of a position in article (a predetermined position in the plate) in the first captured image. For example, the recognition unit 1202 derives, out of eight vertices of the plate having a rectangular parallelepiped shape, a vertex to be the origin of the position in article (the predetermined position in the plate) in the captured image, based on a positional relationship previously set as a positional relationship between the display region by the stencil (label) and the origin of the position in article.

[0106] As the positional relationship between the display region by the stencil (label) and the origin of the position in article, the following information, for example, may be previously set in the article management device 1200. Specifically, information indicating that, when the components of the display items in the display by the stencil (label) are seen so that top portions of the components are positioned upward, a vertex positioned on the lower right side of the display by the stencil (label) on a surface same as that of the display by the stencil (label) is

the origin of the position in article, may be previously set in the article management device 1200. The recognition unit 1202 derives, as positions of the components of the display items in the display by the stencil (label), positions in a case where the origin of the position in article in the captured image is set to a reference. When the processing in step S1702 ends, processing in step S1703 is carried out.

[0107] In step S1703, the obtainment unit 1203 obtains pieces of information stored in the sections of ID in the section of actual article display in the management table 1300 stored in the storage unit 1207.

Next, in step S1704, the collation unit 1204 collates the information recognized in step S1702 with the information obtained in step S1703. When it is recognized that the information recognized in step S1702 is the information of the display by the stencil, the collation unit 1204 collates the information stored in the section of ID in the section of stencil in the section of actual article display out of the pieces of information obtained in step S1703, with the information recognized in step S1702. On the other hand, when it is recognized that the information recognized in step S1702 is the information of the display by the label, the collation unit 1204 collates the information stored in the section of ID in the section of label in the section of actual article display out of the pieces

of information obtained in step S1703, with the information recognized in step S1702.

[0108] Next, in step S1705, the specification unit 1205 specifies, based on the result of collation in step S1703, one plate from the plates managed in the management table 1300. Concretely, the specification unit 1205 specifies, from the pieces of information obtained in step S1703, information that matches the information recognized in step S1702.

[0109] Here, the term match indicates that the information recognized in step S1702 includes a part whose contents and arrangement order completely match those of the components stored in the section of ID in the section of stencil or the section of label in the section of actual article display. In the example illustrated in Fig. 3A and Fig. 3B, the contents of the components of the IDs 305 and 312 displayed by the stencil or the label are 5, 6, 3, 4, 9, 7, -, 0, and 1, and the arrangement order thereof is 5, 6, 3, 4, 9, 7, -, 0, and 1, from the left. Therefore, the specification unit 1205 specifies information in which 5, 6, 3, 4, 9, 7, -, 0, and 1 are arranged in this order from the left, from the section of ID managed in the management table 1300. In not only a case where a part of these components is missing in the information recognized in step S1702 but also a case where a component other than these components is arranged in the information, it is assumed that the information recognized in step

S1702 is not the information whose contents and arrangement order completely match those of the components stored in the section of ID in the section of stencil or the section of label in the section of actual article display.

[0110] Next, in step S1706, the position derivation unit 1206 determines, based on the information acquired in step S1701, whether or not the position of the first image capturing device that captured the first captured image acquired in step S1701 is already known. In the present embodiment, it is assumed that the three-dimensional position of each of the first image capturing devices 430a to 430f attached to the girder 412 and the leg structure 413, the first image capturing devices 430o and 430p attached to the structure installed at the standby position of the transport vehicle 700, the first image capturing devices 430r to 430w attached to the structure installed in the storage space in the factory, and the first image capturing devices 430x and 430y attached to the structure installed in the production line in the factory, is already known. It is assumed that regarding each of these first image capturing devices, the ID of the first image capturing device and the positional information (three-dimensional coordinates (x-y-z coordinates)) of the first image capturing device are associated with each other to be previously registered in the article management device 1200. When the positional

information (three-dimensional coordinates) associated with the ID same as the ID of the first image capturing device acquired in step S1701, is previously registered in the article management device 1200, the position derivation unit 1206 determines that the position of the first image capturing device that captured the first captured image acquired in step S1701 is already known, and in the other cases, the position derivation unit 1206 determines that the position of the first image capturing device that captured the first captured image acquired in step S1701 is not already known.

[0111] When, as a result of the determination in step S1706, the position of the first image capturing device that captured the first captured image acquired in step S1701 is not already known, processing in step S1707 is carried out. In step S1707, the position derivation unit 1206 determines whether or not the positional information of the first image capturing device that captured the first captured image has been acquired in step S1701. When, as a result of this determination, the positional information of the first image capturing device that captured the first captured image has not been acquired in step S1701, the processing proceeds to later-described step S1712.

[0112] When, as a result of the determination in step S1706, the position of the first image capturing device that captured the first captured image

acquired in step S1701 is already known, and when, as a result of the determination in step S1707, the positional information of the first image capturing device that captured the first captured image has been acquired in step S1701, processing in step S1708 is carried out. In step S1708, the position derivation unit 1206 determines whether or not a position in a height direction (z-axis direction) of the display region by the stencil (label) can be specified. Note that a concrete example of a case where it is possible to specify the position in the height direction (z-axis direction) of the display region by the stencil (label) will be described later. When, as a result of the determination in step S1708, it is not possible to specify the position in the height direction (z-axis direction) of the display region by the stencil (label), the processing proceeds to later-described step S1712.

[0113] On the other hand, when, as a result of the determination in step S1708, it has been possible to specify the position in the height direction (z-axis direction) of the display region by the stencil (label), processing in step S1709 is carried out. In step S1709, the position derivation unit 1206 derives the three-dimensional coordinates (x-y-z coordinates) of the display region by the stencil (label), as the three-dimensional position of the plate specified in step S1705.

[0114] Next, in step S1710, the storage unit 1207

updates the information stored in the section of article position in the section of non-actual article display in the management table 1300 as the information with respect to the plate specified in step S1705, to the information indicating the three-dimensional position of the plate derived in step S1709. As above, the present embodiment exemplifies the case where the information stored in the section of article position in the section of non-actual article display in the management table 1300, is the information display position. Further, in the present embodiment, the information indicating the three-dimensional position of the plate derived in step S1709 is an example of an information display position newly derived by the position derivation unit. Further, the information stored in the section of article position in the section of non-actual article display in the management table 1300 before performing the processing in step S1710, is an example of an information display position that is already stored in the storage medium. The information stored in the section of article position in the section of non-actual article display in the management table 1300 is the x-y-z coordinates of the display region by the stencil (label). Therefore, the information display position is the three-dimensional position. As described above, regarding the information display position of the same plate, not only the x-coordinate and the y-coordinate but

also the z-coordinate (the position in the height direction) changes according to the movement of the position of the plate. In the present embodiment, it becomes possible to follow a position of a plate whose existing position changes, by performing the processing in step S1710.

[0115] Next, in step S1711, the output unit 1208 outputs the information indicating the three-dimensional position of the plate specified in step S1705. For example, the output unit 1208 makes a computer display display the information indicating the three-dimensional position of the plate specified in step S1705. Subsequently, the processing according to the flow chart in Fig. 17 ends.

[0116] Here, an example of the method of deriving the three-dimensional position of the display region by the stencil (label) in step S1709 will be described by citing the display region 201 by the stencil illustrated in Fig. 2, as an example. In the example illustrated in Fig. 2, the display region 201 by the stencil is positioned in a region in the vicinity of the middle of the width direction (y-axis direction) of the plate and a region on one end side in the length direction of the plate (the negative direction side of the x-axis), in a region of the plate surface of the plate. In the present embodiment, the three-dimensional position of the display region 201 by the stencil is an example of the information display position.

Fig. 18 is a view explaining an example of a method of deriving the three-dimensional position of the display region 201 by the stencil.

[0117] In Fig. 18, a point P indicates the three-dimensional position of the first image capturing device (x-y-z coordinates of the point P are (x_p, y_p, z_p)). The three-dimensional position of the first image capturing device is, for example, a principal point of the first image capturing device. In the example illustrated in Fig. 18, it is assumed that the z-axis is a direction perpendicular to a surface of the plate (a surface on which the display region 201 by the stencil is formed). Further, it is assumed that the y-axis is a direction parallel to a direction in which the components of the same display item are arranged in the display region 201 by the stencil. Further, it is assumed that the x-axis is a direction parallel to a direction in which different display items are arranged in the display region 201 by the stencil. Further, it is assumed that the x-axis, the y-axis, and the z-axis are perpendicular to one another. Further, in this case, it is assumed that the width direction of the plate is parallel to the y-axis, and the length direction of the plate is parallel to the x-axis, for simplifying the explanation.

[0118] A point S indicates a position of a vertex, out of four vertices of the display region 201 by the stencil, positioned on the negative direction side of

the x-axis and positioned on the positive direction side of the y-axis (x-y-z coordinates of the point S are (x_s, y_s, z_s)). A point O is a foot of a perpendicular of the point P (with respect to the x-y plane) (The point O is an intersection point between the perpendicular of the point P and the x-y plane). In the example illustrated in Fig. 18, it is assumed that the point O is an origin. A point Q is an intersection point between a straight line passing through the point O and parallel to the x-axis, and a straight line passing through the point S and parallel to the y-axis.

[0119] When ∠OPQ is set to β (rad), and a length of a line segment OP (a distance from the point O to the point P) is set to H, L being a length of a line segment OQ (a distance from the point O to the point Q) can be expressed by the following formula (1).

$$L = H\tan\beta \quad \cdots (1)$$

[0120] Further, when ∠OPS is set to α (rad), l being a length of a line segment OS (a length from the point O to the point S) can be expressed by the following formula (2). Further, w_y being a length of a line segment SQ (a distance from the point S to the point Q) can be expressed by the following formula (3).

$$l = H\tan\alpha \quad \cdots (2)$$

$$w_y = (l^2-L^2)^{0.5} \cdots (3)$$

[0121] Therefore, the x-y-z coordinates S (x_s, y_s, z_s) of the point S can be expressed by the following

formula (4).

$$S\ (x_s,\ y_s,\ z_s) = (L,\ w_y,\ 0) \cdots (4)$$

[0122] The present embodiment exemplifies a case where the position derivation unit 1206 derives the x-y-z coordinates (x_s, y_s, z_s) of the point S, as the position of the display region 201 by the stencil, when the length H of the line segment OP, the ∠OPQ (= β), and the ∠OPS (= α) are defined.

[0123] The length H of the line segment OP has a value as a result of subtracting the z-coordinate z_s of the display region 201 by the stencil from the z-coordinate z_p of the point P. Therefore, if the z-coordinate of the display region 201 by the stencil (the position in the height direction (z-axis direction) of the display region 201 by the stencil) is specified, it is possible to derive the length H of the line segment OP. Note that Fig. 18 exemplifies a case where the z-coordinate z_s of the display region 201 by the stencil is 0 (zero), and thus the length H of the line segment OP is equal to the z-coordinate z_p of the point P.

[0124] The position of the point S in the first captured image is derived as follows, for example. The position derivation unit 1206 derives a circumscribed rectangle defined by positions of the components of the display items by the stencil recognized in step S1702, having the maximum value of the x-axis, the minimum value of the x-axis, the maximum value of the y-axis, and the minimum value of

the y-axis. Subsequently, the position derivation unit 1206 derives, when the components of the display items by the stencil are seen so that top portions thereof are positioned upward, a position of a vertex, out of vertices of the derived circumscribed rectangle, positioned on the lower left side (the negative direction side of the x-axis and the positive direction side of the y-axis), for example, as the position of the point S in the first captured image. Note that when the display by the label is performed in the first captured image, the position derivation unit 1206 derives, when the components of the display items by the stencil are seen so that top portions thereof are positioned upward, a vertex positioned on the lower left side, for example, out of vertices of the label having the rectangular shape, as the position of the point S in the first captured image.

[0125] The position of the point Q in the first captured image is a position on a straight line passing through the position of the point S in the first captured image and parallel to the y-axis, and a position corresponding to a center of a horizontal angle of view when performing the image capturing (an angle of view in the y-axis direction). Note that the point Q may also be specified in the following manner, for example. Specifically, laser light is irradiated from the point P by a laser pointer or the like, to thereby display a straight line passing

through the position of the point S and parallel to the y-axis, on a surface on which the display region 201 by the stencil is formed, out of plate surfaces of the plate. Further, laser light is irradiated from the point P by a laser pointer or the like, to thereby display a straight line passing through the point O and parallel to the x-axis, on the surface on which the display region 201 by the stencil is formed, out of the plate surfaces of the plate. In such a case, an intersection point between the two straight lines displayed by the laser light, is the point Q. Therefore, the position derivation unit 1206 may also specify the point Q from the first captured image captured in a state where the intersection point between the two straight lines displayed by the laser light is displayed. If it is designed as above, when the point P, the point O, and the point Q are on the x-z plane (on the plane in which $y = 0$), it is possible to specify the position of the point Q even if the surface on which the display region 201 by the stencil is formed out of the plate surfaces of the plate is inclined with respect to the x-y plane.

[0126] For example, the position derivation unit 1206 may also derive the $\angle OPS$ ($= \alpha$), the $\angle OPQ$ ($= \beta$), and the $\angle SPQ$ = ($= \delta$) in the following manner. First, based on measured values of a distance measuring sensor (a distance measuring sensor of TOF (Time-of-Flight) system, for example) provided to the first image capturing device, the position derivation unit

1206 derives a length of the line segment PS and a length between the points P and Q. Further, the position derivation unit 1206 specifies the positions of the point S and the point Q, by assuming that the surface on which the display region 201 by the stencil is formed is the x-y plane, and the line segment QS is a straight line that extends in the y-axis direction. Subsequently, the position derivation unit 1206 derives the ∠OPS (= α), the ∠OPQ (= β), and the ∠SPQ = (= δ), based on the positions of the point P, the point S, and the point Q.

[0127] Further, for example, the position derivation unit 1206 may also derive the ∠OPS (= α), the ∠OPQ (= β), and the ∠SPQ = (= δ), based on an angle of laser light irradiated from the first image capturing device toward the point S, an angle of laser light irradiated from the first image capturing device toward the point Q, and a scan angle when the laser light was scanned from the point S to the point Q by the first image capturing device.

[0128] Further, the position derivation unit 1206 may also derive the ∠OPS (= α), the ∠OPQ (= β), and the ∠SPQ = (= δ) by counting the number of rectangles arranged in a lattice form in a first captured image captured in a state where a region including the surface on which the display region 201 by the stencil is formed out of the plate surfaces of the plate and the point O was irradiated with laser light in a lattice form. In such a case, a length in the

x-axis direction of one rectangle is a length in the x-axis direction that changes when the ∠OPS (= α) and the ∠OPQ (= β) change by 1 rad, for example, and a length in the y-axis direction of one rectangle is a length in the y-axis direction that changes when the ∠SPQ = (= δ) changes by 1 rad, for example. Based on the result of counting of the number of rectangles from the rectangle at a position corresponding to the point O to the rectangles corresponding to the points S and Q, the ∠OPS (= α) and the ∠OPQ (= β) are derived. Further, based on the result of counting of the number of rectangles from the rectangle at a position corresponding to the point S to the rectangle at a position corresponding to the point Q, the ∠SPQ (= δ) is derived. The counting of the number of rectangles is performed based on a result of image processing with respect to the first captured image.

[0129] Note that regarding the positions of the display regions 1111, 1121, 1131, and 1141 as well, the derivation is performed similarly to the method described while referring to Fig. 18. Further, the display region 201 by the stencil and the display region by the label 202 are different only in a point that the surfaces on which they are disposed in the plate are different, so that the position of the display region by the label 202 can also be derived by following the method described while referring to Fig. 18. Therefore, a detailed explanation thereof

will be omitted here.

[0130] Next, an example of a case where it is determined in step S1708 that the position in the height direction (z-axis direction) of the display region by the stencil (label) can be specified, will be described.

As a first example, the position derivation unit 1206 first derives a distance in the height direction (z-axis direction) from the first image capturing device to the display region by the stencil, by using a laser distance meter. Subsequently, the position derivation unit 1206 derives a position as a result of subtracting the distance from a position in the height direction (z-axis direction) of the first image capturing device, as the position in the height direction (z-axis direction) of the display region 201 by the stencil.

[0131] As a second example, the position derivation unit 1206 derives the position in the height direction (z-axis direction) of the display region by the stencil (label) by using the information indicating the position of the plate stored in the section of article position in the management table 1300, and the information indicating the date and time at which the plate was placed at the current position, stored in the section of registration time in the management table 1300. An example of a method of deriving the position in the height direction (z-axis direction) of the display region by the stencil

(label) as above will be described. Note that in this case, the three-dimensional position of the plate stored in the section of article position in the management table 1300, will be referred to as an article position according to need. Further, in order to simplify the explanation here, it is assumed that a plate at the lowermost position out of a plurality of stacked plates is placed on the ground.

[0132] First, the position derivation unit 1206 specifies, out of plates except for the plate specified in step S1705, a plate that is at least partially included in the image capturing range (x-y coordinates) of the first image capturing device that captured the first captured image acquired in step S1701, based on the article position stored in the management table 1300.

[0133] When deriving the position in the height direction (z-axis direction) of the display region 201 by the stencil, the plate specified in step S1705 is at the uppermost position. Therefore, the position derivation unit 1206 judges that the plate that is at least partially included in the image capturing range (x-y coordinates) of the first image capturing device that captured the first captured image acquired in step S1701, is positioned below the plate specified in step S1705. In this case, a value obtained by adding all of the sizes (thicknesses) stored in the management table 1300 as the information of plates positioned below the plate

specified in step S1705, and a thickness of the plate specified in step S1705, corresponds to the position in the height direction (z-axis direction) of the display region 201 by the stencil.

[0134] On the other hand, when deriving a position in the height direction (z-axis direction) of the display region by the label, the position derivation unit 1206 judges that a plate, out of the plates specified as described above, whose date and time stored in the section of registration time are later than those stored in the section of registration time in the management table 1300 as the information of the plate specified in step S1705, is a plate positioned below the plate specified in step S1705. In this case, a value obtained by adding an added value of all of sizes (thicknesses) stored in the management table 1300 as the information of plates positioned below the plate specified in step S1705, and a value of the z-coordinate of the position in article stored in the management table 1300 as the information of the plate specified in step S1705, corresponds to the position in the height direction (z-axis direction) of the display region by the label 202.

[0135] As a third example, when information capable of specifying the height direction (z-axis direction) is displayed in the first captured image, the position derivation unit 1206 can derive the position in the height direction (z-axis direction) of the

display region by the stencil (label), based on the information. An example of a method of deriving the position in the height direction (z-axis direction) of the display region by the stencil (label) as above, will be described. When, for example, a structure on which a scale indicating the position in the height direction (z-axis direction) is displayed is included in the first captured image, the position derivation unit 1206 recognizes the scale on the structure from the first captured image. For example, the position derivation unit 1206 performs edge detection processing on the first captured image to extract edges of an object, and extracts the structure from the extracted object. For example, information in which information indicating a contour of an object and a name of the object are associated with each other, is registered beforehand in the article management device 1200. In such a case, the position derivation unit 1206 may compare the edges of the object extracted as described above and the information, to thereby extract the object corresponding to the structure. Further, the position derivation unit 1206 may use AI (Artificial Intelligence), for example, NN (Neural Network), to thereby extract the structure from the object extracted as described above.

[0136] Subsequently, the position derivation unit 1206 derives the position in the height direction (z-axis direction) of the display region by the stencil

(label), based on the position of the display region by the stencil (label) in the first captured image and the position of the scale displayed on the structure in the first captured image. Note that a numeric character on the scale in the first captured image is recognized by a method similar to the method of recognizing the components of the display item by the stencil (label).

[0137] As a fourth example, the position derivation unit 1206 may use a second captured image acquired by the second image acquisition unit 1209, to thereby derive the position in the height direction (z-axis direction) of the display region 201 by the stencil. In this case, in the flow chart in Fig. 17, a step of acquiring the second captured image by the second image acquisition unit 1209, is added at a timing before the timing of starting the processing in step S1708. The second captured image is a captured image captured by the second image capturing device that is different from the first image capturing device that captured the first captured image (the image capturing device that captures the region including the display region by the stencil (label)). The second captured image includes both the first image capturing device that captured the first captured image acquired in step S1701, and the plate to be specified in step S1705. An example of a method of deriving the position in the height direction (z-axis direction) of the display region 201 by the stencil

as above, will be described.

[0138] Fig. 19 is a view explaining an example of a method of deriving the position in the height direction (z-axis direction) of the display region 201 by the stencil.

Also in the example illustrated in Fig. 19, a point P indicates the position of the first image capturing device (x-y-z coordinates of the point P are (x_p, y_p, z_p)), similarly to Fig. 18. Further, the z-axis is a direction perpendicular to a surface of the plate (a surface on which the display region 201 by the stencil is formed). Further, the y-axis is a direction parallel to a direction in which the components of the same display item are arranged in the display region 201 by the stencil. Further, the x-axis is a direction parallel to a direction in which different display items are arranged in the display region 201 by the stencil. Further, it is assumed that the x-axis, the y-axis, and the z-axis are perpendicular to one another. Also in this case, it is assumed that the width direction of the plate is parallel to the y-axis, and the length direction of the plate is parallel to the x-axis, for simplifying the explanation.

[0139] Further, a point O' is an intersection point between a perpendicular of the point P (with respect to the x-y plane) and a plane including the surface of the plate (the surface on which the display region 201 by the stencil is formed) (the point O'

corresponds to the point O in Fig. 18). The point O is a foot of the perpendicular of the point P (with respect to the x-y plane) (The point O is an intersection point between the perpendicular of the point P and the x-y plane). In the example illustrated in Fig. 19, it is assumed that the point O is an origin. A point R indicates a three-dimensional position of the second image capturing device (x-y-z coordinates of the point R are (x_r, y_r, z_r)). The three-dimensional position of the second image capturing device is, for example, a position of a principal point of the second image capturing device.

[0140] It is assumed that the three-dimensional position of the second image capturing device can be specified by the article management device 1200. For example, when the three-dimensional position of the second image capturing device is fixed, an ID of the second image capturing device and the three-dimensional coordinates (x-y-z coordinates) of the second image capturing device are associated with each other, and previously registered in the article management device 1200. Further, when the three-dimensional position of the second image capturing device is not fixed, for example, the second image capturing device transmits the three-dimensional coordinates (x-y-z coordinates) of the second image capturing device measured by using the GPS, and the ID of the second image capturing device. In this

case, the second image acquisition unit 1209 acquires these pieces of information transmitted from the second image capturing device.

[0141] In the example illustrated in Fig. 19, it is assumed that a plate at the lowermost position out of a plurality of stacked plates is placed on the ground, in order to simplify the explanation. A point D is a vertex at a position closest to the point R, out of vertices of a surface on which the display region 201 by the stencil is formed. A point B is a vertex at a position closest to the point R, out of vertices of a bottom surface of the plate at the lowermost position out of the plurality of stacked plates.

[0142] In Fig. 19, $\angle$BRD ($= \phi_B$) and $\angle$PRO ($= \phi_P$) are determined based on the positions of the point P, the point B, and the point D in the second captured image, and a principal point of the second captured image, for example. By a straight line connecting the point P in the second captured image and the principal point of the second captured image, a direction in which a line segment RP extends is specified. By a straight line connecting the point B in the second captured image and the principal point of the second captured image, a direction in which a line segment RB extends is specified. By a straight line connecting the point D in the second captured image and the principal point of the second captured image, a direction in which a line segment RT extends is specified. The $\angle$BRD ($= \phi_B$) is determined based on

the direction in which the line segment RB extends and the direction in which the line segment RD extends. The ∠PRO (= ϕ_P) is determined based on the direction in which the line segment RP extends and the y-axis direction.

[0143] Further, for example, the position derivation unit 1206 derives, based on measured values of a distance measuring sensor (a distance measuring sensor of TOF (Time-of-Flight) system, for example) provided to the second image capturing device, a length of the line segment RP (a distance from the point R to the point P) and a length of the line segment RD (a distance from the point R to the point D). Subsequently, the position derivation unit 1206 derives, based on a position in the height direction (z-axis direction) (z_r) of the second image capturing device, the length of the line segment RP, and the ∠PRO (= ϕ_P), the position in the height direction (z-axis direction) (z_p) of the first image capturing device ($z_p = z_r$ + length of line segment RP × $\sin\phi_P$). In like manner, the position derivation unit 1206 derives, based on the position in the height direction (z-axis direction) (z_r) of the second image capturing device, the length of the line segment RD, and the ∠BRD (= ϕ_B), the position in the height direction (z-axis direction) of the display region 201 by the stencil.

[0144] Note that Fig. 19 exemplifies the case where the position in the height direction (z-axis

direction) of the second image capturing device (the point R) is 0 (zero). Further, if the second captured image is used as described above, the position derivation unit 1206 can derive not only the position in the height direction (z-axis direction) of the display region 201 by the stencil but also the position in the height direction (z-axis direction) (z_p) of the first image capturing device. Further, the position derivation unit 1206 can derive not only the position in the height direction (z-axis direction) but also the position in the x-axis direction (x_p) and the position in the y-axis direction (y_p) of the first image capturing device. For example, x_p and y_p are derived based on the direction in which the line segment RP extends, and y_r + length of line segment RP × $\cos\phi_P$. Specifically, a vector connecting the points R and P is derived based on the direction in which the line segment RP extends, and y_r + length of line segment RP × $\cos\phi_P$. A length of an x-axis component and a length of a y-axis component of the vector correspond to x_p and y_p, respectively.

[0145] Further, the case where the point P (the first image capturing device) is included in the second captured image captured by the second image capturing device has been described here as an example. However, this does not always have to be designed as above as long as it is possible to derive the relative positional relationship (the $\angle PRO$ (= ϕ_P),

and the like) between the first image capturing device (the point P) and the second image capturing device (the point R). In such a case, for example, a captured image captured by at least one image capturing device that is different from the first image capturing device and the second image capturing device, is used. A concrete example in such a case will be described. First, a third image capturing device is disposed, in addition to the first image capturing device and the second image capturing device. It is assumed that the third image capturing device includes the point P (the first image capturing device) and the point R (the second image capturing device) in its image capturing range, and it does not include the point D in its image capturing range. Further, a point indicating a position of the third image capturing device is assumed to be R', which is not illustrated. Further, it is assumed that one or both of the position of the point R indicating the position of the second image capturing device and the position of the point R' indicating the position of the third image capturing device is/are previously determined. In this case, the position derivation unit 1206 derives, based on a third captured image captured by the third image capturing device, an elevation angle or a depression angle when the point R and the point P are seen from the point R'. Subsequently, the position derivation unit 1206 derives the $\angle PRO$ ($= \phi_P$) based on the

derived elevation angle or depression angle. The derivation of angles, directions, and lengths is realized by a method similar to that described while referring to Fig. 19. Further, when the image capturing range of the third image capturing device includes the point P (the first image capturing device) and does not include the point R (the second image capturing device), it is only required to further use, for example, a fourth captured image captured by a fourth image capturing device that includes the point R' (the third image capturing device) and the point R (the second image capturing device) in its image capturing range. On the other hand, for example, when the image capturing range of the third image capturing device includes the point R (the second image capturing device) and does not include the point P (the first image capturing device), it is only required to further use, for example, a fifth captured image captured by a fifth image capturing device that includes the point R' (the third image capturing device) and the point P (the first image capturing device) in its image capturing range.

[0146] Further, the position derivation unit 1206 may also specify the position of the point P (the first image capturing device) by using a sixth captured image captured by a sixth image capturing device that includes the first image capturing device in its image capturing range. In this case, it is

assumed that the sixth image capturing device is included in the image capturing range of at least one of the second image capturing device, the third image capturing device, and the fourth image capturing device. Further, a point indicating a position of the sixth image capturing device is assumed to be P', which is not illustrated. Further, it is assumed that one or both of the position of the point P indicating the position of the first image capturing device and the position of the point P' indicating the position of the sixth image capturing device is/are previously determined. In this case, for example, calculation using the sixth image capturing device and the point P', instead of using the first image capturing device and the point P, is performed in the above-described explanation. Subsequently, for example, based on the result of this calculation, the sixth captured image, and the position(s) of one or both of the point P and the point P', the relative positional relationship (the $\angle PRO$ ($= \phi_P$) and the like) between the first image capturing device (the point P) and the second image capturing device (the point R) is derived.

[0147] When designed as above, even in a case where the second image capturing device cannot be arranged so as to make the image capturing range of the second image capturing device include both the first image capturing device and the plate, it is possible to derive the position in the height direction (z-axis

direction) of the display region 201 by the stencil. Note that the third to sixth captured images are acquired by the second image acquisition unit 1209, for example. However, it is also possible to use third to sixth image acquisition units that individually acquire the third to sixth captured images, separately from the second image acquisition unit 1209. In such a case, in the flow chart in Fig. 17, at a timing before the timing of starting the processing in step S1708 and a timing separately from the timing of executing the step of acquiring the second captured image by the second image acquisition unit 1209, a step of individually acquiring the third to sixth captured images is added. Note that when the position in the height direction (z-axis direction) of the display region by the stencil (label) can be specified without acquiring the second captured image and the like, the second image acquisition unit 1209 becomes unnecessary.

[0148] As a fifth example, the position derivation unit 1206 may derive the position in the height direction (z-axis direction) of the display region 201 by the stencil of each of plates 1002a and 1002b placed on a conveyor table 1001, based on a position of the conveyor table 1001 and sizes (thicknesses) stored in the management table 1300 as information of the plates 1000a and 1002b. In such a case, the position of the conveyor table 1001 is previously registered in the article management device 1200.

[0149] For example, when the position in the height direction (z-axis direction) of the display region by the stencil (label) can be derived in at least one example out of the above-described examples, it is determined in step S1708 that the position in the height direction (z-axis direction) of the display region by the stencil (label) can be specified.

[0150] Further, when a plate is in a carrier, the position derivation unit 1206 acquires a three-dimensional position of the plate in the carrier in step S1709. In the present embodiment, the carrier is the transport ship 400 and the transport vehicle 700. Accordingly, the present embodiment exemplifies a case where the carrier is the transport ship 400 and the transport vehicle 700.

For example, when a plate is loaded into the transport ship 400, the position derivation unit 1206 acquires an ID of the plate and information indicating a three-dimensional position of the plate in the transport ship 400. Further, the position derivation unit 1206 specifies, from the section of ID in the management table 1300, a column on which information indicating an ID same as the acquired ID of the plate is stored. Subsequently, the position derivation unit 1206 stores, in the section of article position on the specified column, the acquired information indicating the three-dimensional position of the plate in the transport ship 400. For example, an operator (worker) of the transport ship

400 may input the ID of the plate and the information indicating the three-dimensional position of the plate in the transport ship 400, in an information processing terminal (a tablet terminal or the like) held by the operator (worker). In such a case, it is possible to transmit the ID of the plate and the information indicating the three-dimensional position of the plate in the transport ship 400 from the information processing terminal to the article management device 1200, to thereby make the position derivation unit 1206 acquire the ID of the plate and the information indicating the three-dimensional position of the plate in the transport ship 400. The information indicating the three-dimensional position of the plate is, for example, the x-y-z coordinates of the display region by the stencil (label).

[0151] Further, when a plate is loaded into the transport vehicle 700, the position derivation unit 1206 acquires an ID of the plate and information indicating a three-dimensional position of the plate in the transport vehicle 700. Further, the position derivation unit 1206 specifies, from the section of ID in the management table 1300, a column on which information indicating an ID same as the acquired ID of the plate is stored. Subsequently, the position derivation unit 1206 stores, in the section of article position on the specified column, the acquired information indicating the three-dimensional position of the plate in the transport vehicle 700.

For example, an operator (worker) of the transport vehicle 700 may input the ID of the plate and the information indicating the three-dimensional position of the plate in the transport vehicle 700, in an information processing terminal (a tablet terminal or the like) held by the operator (worker). In such a case, it is possible to transmit the ID of the plate and the information indicating the three-dimensional position of the plate in the transport vehicle 700 from the information processing terminal to the article management device 1200, to thereby make the position derivation unit 1206 acquire the ID of the plate and the information indicating the three-dimensional position of the plate in the transport vehicle 700. The information indicating the three-dimensional position of the plate is, for example, the x-y-z coordinates of the display region by the stencil (label).

[0152] By acquiring the three-dimensional position of the plate in the carrier in the manner as described above, it is possible to specify the carrier that conveys each plate. Further, it is possible to accurately specify the three-dimensional position of the plate when it is being conveyed by the carrier.

[0153] As a sixth example, it is possible that an image capturing device in which the number of pixels and a size (a length of each pixel [m/pixel]) of an image capturing sensor, and a focal distance being a

distance from the image capturing sensor to a principal point are known, is used to acquire a position in a real space of the display region by the stencil (label), thereby deriving the position in the height direction (z-axis direction) of the display region by the stencil (label).

[0154] The sixth example will be described by using Fig. 20A and Fig. 20B, by citing a case, as an example, in which the display region 201 by the stencil is a rectangle, and lengths of a long side and a short side thereof in the real space are previously stored in the article management device 1200. Note that as described above, the information regarding the number of pixels of the sensor of the first image capturing device, the information regarding the size of the sensor, and the focal distance per optical magnification used when performing photographing, are previously stored in the article management device 1200. The focal distance is information that is determined when performing image capturing.

[0155] Fig. 20A is a view illustrating an example of a first captured image including the display region 201 by the stencil. The display region 201 by the stencil is a rectangle in the first captured image when an image thereof is captured from the front. On the other hand, when an image of the display region 201 by the stencil is captured from a diagonal direction, the region is sometimes a trapezoid in the

first captured image, as indicated by a dotted line (virtual line) in Fig. 20A. Fig. 20B is a view illustrating an example of geometrical relation between an inside of the first image capturing device and the display region 201 by the stencil. In Fig. 20B, the position derivation unit 1206 first specifies positions of vertices 002a to 2002d at four corners of a display region 201' by the stencil captured by an image capturing sensor 2002. Next, the position derivation unit 1206 specifies straight lines 2003a to 2003d being straight lines connecting the vertices 2002a to 2002d at four corners of the display region 201' by the stencil and a principal point FP and extended toward the display region 201 by the stencil. Next, the position derivation unit 1206 specifies a quadrangular pyramid 2001 in which the principal point FP is a vertex, the straight lines 2003a to 2003d are four sides whose one end is the principal point FP, respectively, and dimensions of a bottom surface are lengths in the real space of a long side and a short side of the display region 201 by the stencil (rectangle). As described above, when the display region 201 by the stencil is set to the rectangle, the lengths in the real space of the long side and the short side of the rectangle are previously stored in the article management device 1200. The position derivation unit 1206 derives, based on the quadrangular pyramid 2001 specified as above, a three-dimensional positional relationship

between the display region 201 by the stencil and the principal point FP (the first image capturing device).

[0156] Here, in order to simplify the explanation, the case has been exemplified in which the shape of the display region by the stencil is the rectangle whose dimensions are previously known. However, in the method of the sixth example, the shape of the display region to be a target of deriving the three-dimensional positional relationship with respect to the first image capturing device is not limited to the rectangle. For example, even with the display of a character, a symbol, a mark, or the like whose shape and size are previously known, it is possible to derive the three-dimensional positional relationship between a position of the display and the principal point (the first image capturing device) by replacing the display region 201 by the stencil illustrated in Fig. 20B with a display region of the display.

[0157] Furthermore, the case has been exemplified here in which the display region to be a target of deriving the three-dimensional positional relationship with respect to the first image capturing device is a plane. However, in the method of the sixth example, the display region to be a target of deriving the three-dimensional positional relationship with respect to the first image capturing device is not limited to the plane. As long as the shape of the surface of the display

region is already known, it is possible to derive the three-dimensional positional relationship between the display region and the first image capturing device. For example, when the position derivation unit 1206 derives a three-dimensional positional relationship between a display region of a display performed on a surface of a cylindrical article and the first image capturing device, a shape and dimensions of the display region, and a curvature of a display surface of the display region, in place of the dimensions of the long side and the short side of the rectangle described while referring to Fig. 20B, are only required to be stored in advance in the article management device 1200. This is because, based on these pieces of information, it is possible to specify one corresponding to the bottom surface of the quadrangular pyramid in the method of the sixth example described while referring to Fig. 20B.

[0158] Returning to the explanation of Fig. 17, when it is determined in step S1708 that the position in the height direction (z-axis direction) of the display region by the stencil (label) cannot be specified, the processing in step S1712 is carried out. In step S1712, the output unit 1208 outputs information indicating that the three-dimensional position of the plate cannot be specified, and the ID of the first image capturing device that captured the image of the plate. For example, the output unit 1208 makes a computer display display the information

indicating that the three-dimensional position of the plate cannot be specified, and the ID of the first image capturing device that captured the image of the plate. When these pieces of information are output, an operator (worker) goes to a position where the corresponding first image capturing device exists, and specifies a three-dimensional position of the corresponding plate. Further, the operator (worker) may also specify the three-dimensional position of the corresponding plate from a preview image of the corresponding first image capturing device.

[0159] Next, in step S1713, the storage unit 1207 makes the information indicating the three-dimensional position of the plate specified by the operator (worker) input therein, and updates information stored in the section of article position in the section of non-actual article display in the management table 1300 as information with respect to the plate, to the input information. Note that as a form of the input of the information indicating the three-dimensional position of the plate, at least one of an input by an operation of the user interface of the article management device 1200, reception of information transmitted from an external device, and reading of information stored in a portable storage medium, can be employed. The processing according to the flow chart in Fig. 17 is then terminated.

[0160] <Summary>

As described above, in the present embodiment,

the article management device 1200 acquires the first captured image of the region including the display region in which the information displayed on the plate and managed by the manufacturer of the plate is displayed by the stencil (label). The article management device 1200 derives the three-dimensional position of the display region by the stencil (label) based on the acquired first captured image, and the position of the first image capturing device that captured the first captured image, and stores the information indicating the three-dimensional position in the storage medium while associating the information with the ID of the plate. Therefore, even when, for example, the plates are conveyed by using the various kinds of conveying devices (the transport ship 400, the transport vehicle 700, the conveyor table 1001, and the like), the plates are conveyed by a worker, the plates are placed in a storage space whose address is not determined, or the plates are placed in a stacked manner, it is possible to manage a position of each of the plates. Therefore, it is possible to properly manage the position of each of the plates.

[0161] Further, in the present embodiment, in a case where a three-dimensional position of the display region by the stencil (label) is newly derived when the three-dimensional position of the display region by the stencil (label) and the ID of the plate are already stored in the storage medium in a mutually

associated manner, the article management device 1200 updates the three-dimensional position of the display region by the stencil (label) that is already stored in the storage medium to the newly derived three-dimensional position. Therefore, it is possible to improve the accuracy of following the position of the plate whose existing position (place) changes with time.

[0162] Further, in the present embodiment, the article management device 1200 recognizes, based on the first captured image, the information (IDs 305 and 312) displayed on the display region by the stencil (label). Subsequently, the article management device 1200 collates the recognized information with the information (ID) stored in the management table 1300, and it specifies the plate based on the result of collation. Therefore, it is possible to securely specify the plate itself to be the management target of position, based on the first captured image. Accordingly, it is possible to specify the position of the plate with high accuracy, when compared to a case where the three-dimensional position of the plate is specified based on an operation of a conveyor, for example.

[0163] Further, in the present embodiment, the article management device 1200 acquires the second captured image captured by the second image capturing device that is different from the first image capturing device that captured the first captured

image. The second captured image includes the first captured image and the plate (to be the management target of position). The article management device 1200 derives, based on the acquired second captured image and the position of the second image capturing device, the position in the height direction (z-axis direction) of the display region 201 by the stencil. Subsequently, the article management device 1200 derives, based on the position in the height direction (z-axis direction) of the display region 201 by the stencil, the first captured image, and the position of the first image capturing device that captured the first captured image, the three-dimensional position of the display region 201 by the stencil, as the three-dimensional position of the plate. Therefore, even in a case where the position in the height direction of the plate cannot be derived even if the first captured image and the sensor provided to the first captured image are used, it is possible to manage the position of the plate.

[0164] Further, in the present embodiment, it is set that the display by the stencil and the display by the label are the pieces of information capable of being identified by a person. Therefore, it becomes easy to perform management of actual articles by an operator (worker). Consequently, the convenience in the management of actual articles is improved.

[0165] Further, in the present embodiment, it is set that each of the display by the stencil and the

display by the label includes the information that is individually defined for each plate (information peculiar to the plate). Accordingly, it is possible to uniquely identify the plate based on the first captured image. Therefore, the identification of plate can be performed easily and quickly.

[0166] Further, in the present embodiment, the article management device 1200 derives the three-dimensional coordinates (x-y-z coordinates), as the position of the display region by the stencil (label). Therefore, even in a case where a plurality of plates are stacked, for example, it is possible to manage the positions of the plates.

[0167] <Modified examples>

<<First modified example>>

The method of deriving the position of the display region by the stencil (label) included in the first captured image in step S1709, is not limited to the method described while referring to Fig. 18. For example, the position derivation unit 1206 derives, from the first captured image, the position of origin when determining the position in article in the management table 1300. Subsequently, the position derivation unit 1206 derives, based on the derived position of origin, and the information stored in the section of position in article in the management table 1300, the position of the display region by the stencil (label) included in the first captured image. An example of the method of deriving the position of

the display region by the stencil (label) included in the first captured image as above, will be described by citing the display region 201 by the stencil as an example.

[0168] Fig. 21 is a view explaining an example of a method of deriving the position of the display region 201 by the stencil. Fig. 21 exemplifies a case where x-y-z coordinates S (x_s, y_s, z_s) of a point S are derived as the position of the display region 201 by the stencil, similarly to Fig. 18. As described while referring to Fig. 14, the position in article of the stencil is expressed by the x-y coordinates in which the vertex 203 illustrated in Fig. 2 is set to an origin, a direction along a width direction of the plate from the vertex 203 is set to a positive direction of the y-axis, and a direction along a length direction of the plate from the vertex 203 is set to a positive direction of the x-axis. Therefore, a position of a point E in Fig. 21 becomes an origin of the position in article of the stencil. A point F is a point that is arranged in the width direction (y-axis direction) with respect to the point E, out of the vertices of the plate (the point E and the point F form one side along the width direction of the plate). A point T is a foot of a perpendicular of the point P with respect to a line segment EF (an intersection point between the perpendicular of the point P and the line segment EF). The point P and the point O are the same as those illustrated in Fig.

18.

[0169] In Fig. 21, a length of a line segment PT is set to h_p. Further, a length of a line segment PF is set to h_1, $\angle FPT$ is set to θ_1 (rad), a length of a line segment PE is set to h_2, $\angle EPT$ is set to θ_2 (rad), and $\angle EPF$ is set to θ (rad) ($\theta = \theta_1 + \theta_2$). Further, a length of a line segment FT is set to w_{01}, and a length of a line segment ET is set to w_{02}.

[0170] Accordingly, an x-coordinate x_e of the point E has a value as a result of adding a length l_p of a line segment OT to an x-coordinate x_p of the point P ($x_e = x_p + l_p$). A y-coordinate y_e of the point E has a value as a result of subtracting the length w_{o2} of the line segment ET from a y-coordinate y_p of the point P ($y_e = y_p - w_{o2}$). Therefore, if the length l_p of the line segment OT and the length w_{o2} of the line segment ET are derived, the x-y coordinates (x_e, y_e) at the position of the point E (the origin of the position in article of the stencil) are derived.

[0171] The length l_p of the line segment OT is expressed by the following formula (5).

$$l_p = \sqrt{(h_p^2 - H^2)} = \sqrt{(h_1^2 \cos^2\theta_1 - H^2)} = \sqrt{(h_2^2 \cos^2\theta_2 - H^2)} \quad \cdots (5)$$

The length w_{o2} of the line segment ET is expressed by the following formula (6).

$$w_{o2} = h_2 \sin\theta_2 \quad \cdots (6)$$

Therefore, if, for example, the length h_2 of the line segment PE and the $\angle EPT$ ($= \theta_2$) are derived, the length l_p of the line segment OT and the length w_{o2} of

the line segment ET are derived. Note that the length H of the line segment OP is derived in a manner as described above while referring to Fig. 18.

[0172] A position of the point T in the first captured image is a position on the line segment EF in the first captured image and a position corresponding to a center of a horizontal angle of view when performing the image capturing (an angle of view in the y-axis direction). The ∠EPT (= θ_2) is determined based on the positions of the point E and the point T in the first captured image acquired in step S1701, and a principal point of the first captured image, for example. By a straight line connecting the point E in the first captured image and the principal point of the first captured image, a direction in which the line segment PE extends is specified. By a straight line connecting the point T in the first captured image and the principal point of the first captured image, a direction in which the line segment PT extends is specified. The ∠EPT (= θ_2) is determined based on the direction in which the line segment PE extends and the direction in which the line segment PT extends.

The length h_2 of the line segment PE is derived by using, for example, a distance measuring sensor (a distance measuring sensor of TOF (Time-of-Flight) system, for example) provided to the first image capturing device. Other than the above, it is also possible to derive the length h_2 of the line segment

PE based on the length H of the line segment OP and ∠OPE.

[0173] The x-coordinate x_e and the y-coordinate y_e of the point E are derived as described above. Further, the position derivation unit 1206 reads x-y coordinates (Ls10, Ws10) at a position corresponding to the point S, from the information stored in the section of position in article in the management table 1300 as the information of the label of the plate specified in step S1705. Subsequently, the position derivation unit 1206 derives a value as a result of adding LS10 to the x-coordinate x_e of the point E, as an x-coordinate x_s of the point S ($x_s = x_e + LS10$). Further, the position derivation unit 1206 derives a value as a result of adding WS10 to the y-coordinate x_y of the point E, as a y-coordinate y_s of the point S ($y_s = y_e + WS10$).

[0174] Further, for example, depending on at least one of the place where the plate is placed, the position of the display region by the stencil (label), and the direction in which the plate is placed, the numerical formula expressing the geometrical positional relationship between the display region by the stencil (label) and the first image capturing device does not become the formula explained while referring to Fig. 18 and Fig. 21 in some cases. For example, when a plurality of plates are stacked in a freight car, and an image capturing device cannot capture an image of a part of the plurality of plates,

a position in the height direction of a plate placed at the uppermost position, out of the plurality of plates, is not determined in some cases. Further, the mathematical formula expressing the geometrical positional relationship between the display region by the stencil (label) and the first image capturing device sometimes becomes complicated. Accordingly, for example, the first image capturing device may also capture a luminance image and a distance image as a first captured image. Note that the luminance image corresponds to the captured image explained so far in the present embodiment. The luminance image includes information regarding intensity of reflected light from a subject (brightness of the subject), and does not include information regarding a distance from the image capturing device to the subject. The distance image includes information regarding the distance from the image capturing device to the subject. Note that the first image capturing device captures the luminance image and the distance image so that a position of pixel of the luminance image and a position of pixel of the distance image correspond to each other. Further, a method of measuring the distance image may employ a well-known method, for example, a TOF (Time Of Flight) system or a pattern irradiation system.

[0175] If it is designed as above, the position derivation unit 1206 specifies a pixel corresponding to the display region by the stencil (label) based on

the luminance image. For example, the position derivation unit 1206 previously stores an image of the stencil (label), as a template image. The position derivation unit 1206 performs pattern matching between the luminance image and the template image, to thereby specify the display region by the stencil (label) from the luminance image. The position derivation unit 1206 specifies a region of the distance image corresponding to the display region by the stencil (label) specified from the luminance image. The position derivation unit 1206 extracts a pixel value of the region specified from the distance image. The pixel value of the distance image is a value indicating a distance from the first image capturing device to the subject. The pixel value extracted from the distance image as described above indicates a distance from the first image capturing device to the display region by the stencil (label). In a manner as described above, the position derivation unit 1206 can obtain the distance from the first image capturing device to the predetermined position of the display region by the stencil (label), based on the pixel value extracted from the distance image. The position derivation unit 206 derives a three-dimensional position (x-y-z coordinates) of the predetermined position of the display region by the stencil (label), based on a three-dimensional position (x-y-z coordinates) of the first image capturing device, a posture of the first

image capturing device at the time of capturing the first captured image, and the distance from the first image capturing device to the predetermined position of the display region by the stencil (label).

[0176] <<Second modified example>>

As in the present embodiment, it is preferable that the customer name 302, the standard 303, the size 304, the ID 305, the customer code 306, the order number 307, the standard 311, the ID 312, the size 313, the delivery date 314, and the customer code 315 are set to the pieces of information capable of being identified by a person, since it becomes easy to perform management of actual articles by an operator (worker). However, at least one of the customer name 302, the standard 303, the size 304, the ID 305, the customer code 306, the order number 307, the standard 311, the ID 312, the size 313, the delivery date 314, and the customer code 315 may also be set to information obtained through conversion (encoding) into information that cannot be identified by a person, for example, a barcode and a two-dimensional code.

[0177] <<Third modified example>>

The present embodiment has exemplified the case where the ID 305 displayed by the stencil and the ID 312 displayed by the label are the same, as illustrated in Fig. 3A and Fig. 3B. However, the expressions and description contents are sometimes different between these IDs. For example, there is

also a form of ID in which "hyphen" is omitted. In such a case, information indicating that these IDs (the ID by the stencil and the ID by the label) are for the same plate, is stored in the management table 1300. Regarding the display items other than ID as well, the expressions and the description contents of the same display item are sometimes different between the display by the stencil and the display by the label. For example, when the standard is displayed on both the stencil and the label, an abbreviated name of the standard is sometimes displayed on the label, for example. Further, although a digit number of the customer code is sometimes different between the display by the stencil and the display by the label, the customer code is managed by the manufacturer. Further, regarding the size as well, not all digits of the dimension are not indicated in some cases. Also in such a case, information indicating that those different expressions and description contents have the equivalent meanings, is stored in the management table 1300.

[0178] <<Fourth modified example>>

The present embodiment has exemplified the case where the three-dimensional position (x-y-z coordinates) of the display region by the stencil (label) are derived as the three-dimensional position of the plate. However, the three-dimensional position of the plate is not limited to the three-dimensional position (x-y-z coordinates) of the

display region by the stencil (label). For example, the article management device 1200 may recognize only one element displayed on the surface of the plate, and set x-y-z coordinates at a position (a barycenter or a centroid, for example) of the recognized element to the three-dimensional position of the plate. The element is information dealt as one piece of information, for example, a character, a numeric character, a symbol, and a mark. For example, the element is information that is recognized as one piece of information by the recognition unit 1202. The article management device 1200 may also recognize one element out of the components of the display items in the display by the stencil (label), for example. Further, the article management device 1200 may also recognize one element different from the components of the display items in the display by the stencil (label). When the article management device 1200 derives a three-dimensional position of one element as a three-dimensional position of the plate as described above, it performs the processing described in the present embodiment by regarding a circumscribed rectangle of the recognized one element as the display region 201 by the stencil, for example.

[0179] Further, the article management device 1200 may also recognize only two or more of elements displayed on the surface of the plate. The two or more of elements displayed on the surface of the plate correspond to, for example, two or more of

components out of the components of the display items in the display by the stencil (label). However, it is set that the two or more of elements displayed on the surface of the plate are not all of the components of the display items in the display by the stencil (label). Further, the two or more of elements displayed on the surface of the plate may also be elements different from the components of the display items in the display by the stencil (label). When the article management device 1200 derives a three-dimensional position of the two or more of elements as a three-dimensional position of the plate as described above, it performs the processing described in the present embodiment by regarding a circumscribed rectangle of the two or more of elements displayed on the surface of the plate as the display region 201 by the stencil, for example.

[0180] Further, even if characters have the same size, an image of the character at a position distant from the image capturing device is captured smaller than the character at a position close to the image capturing device. By utilizing this, the position derivation unit 1206 may derive a three-dimensional position of an article based on a position and a size of the information displayed on the first captured image.

[0181] <<Fifth modified example>>

Further, the article management device 1200 may also include a direction derivation unit. The

direction derivation unit derives, based on a plurality of three-dimensional positions (x-y-z) at one surface of an article, information that specifies a direction in which the article is placed. For example, the direction derivation unit derives an angle made by a plate surface of the plate and a reference plane, based on three-dimensional positions (x-y-z coordinates) of the two vertices 1401a and 1401b of the circumscribed rectangle illustrated in Fig. 14. The reference plane is the ground, for example. The reference plane may be one other than the ground. In this case, an angle made by the plate surface of the plate and the reference plane, is an example of information that specifies the direction in which the article is placed. However, the information that specifies the direction in which the article is placed is not limited to the angle made by the plate surface of the plate and the reference plane. For example, a symmetry axis (center axis) of the article may also be used, in place of the plate surface of the article.

[0182] Further, the direction derivation unit may also use three-dimensional positions (x-y-z coordinates) of two or more of components out of the components of the display items by the stencil (label), in place of or in addition to the two vertices 1401a and 1401b of the circumscribed rectangle illustrated in Fig. 14. Further, the direction derivation unit may also use, in place of

or in addition to these three-dimensional positions (x-y-z coordinates), a three-dimensional position (x-y-z coordinates) of information displayed on a region different from the display region by the stencil (label).

[0183] Further, when the present modified example is employed, a section in which the information that specifies the direction in which the article is placed is stored, is added to the section of non-actual article display in the management table 1300 illustrated in Fig. 13. In the explanation below, the section in which the information that specifies the direction in which the article is placed is stored, is referred to as a section of article direction. The storage unit 1207 stores the information that specifies the direction in which the plate is placed, in the section of article direction corresponding to the plate in the management table 1300. Accordingly, the information that specifies the direction in which the plate is placed, and the ID and the three-dimensional position of the plate, and the like are stored in a mutually associated manner.

[0184] Note that when the plate surface of the plate is inclined with respect to the ground, the position in the height direction (z-axis direction) of a position (point) of the derivation target of the three-dimensional position (x-y-z coordinates) is derived in the following manner, for example. First,

the position derivation unit 1206 derives a distance in the height direction (z-axis direction) from the first image capturing device to the information (point) of the derivation target of the three-dimensional position (x-y-z coordinates) by using a laser distance meter. Subsequently, the position derivation unit 1206 derives a position as a result of subtracting the distance from a position in the height direction (z-axis direction) of the first image capturing device, as the position in the height direction (z-axis direction) of the information (point) of the derivation target of the three-dimensional position (x-y-z coordinates).

[0185] Further, the position derivation unit 1206 may also derive the three-dimensional position (x-y-z coordinates) of the information (point) of the derivation target of the three-dimensional position (x-y-z coordinates) based on the luminance image and the distance image, as described in the <<first modified example>>.

[0186] <<Sixth modified example>>

The present embodiment has exemplified the case where the x-y-z coordinates of the display region by the stencil (label) are derived as the three-dimensional position of the display region by the stencil (label). However, the three-dimensional position of the display region by the stencil (label) is not limited to the x-y-z coordinates. For example, the three-dimensional position of the display region

by the stencil (label) may also be a relative three-dimensional position in a case where the position of the first image capturing device is set to a reference. In such a case, the coordinates (x_p, y_p, z_p) of the point P indicating the three-dimensional position of the image capturing device may not be used. Note that when the origin of the x-y-z coordinates is set to the three-dimensional position of the first image capturing device, even if the three-dimensional position of the display region by the stencil (label) is expressed by the x-y-z coordinates, it indicates a relative three-dimensional position in a case where the three-dimensional position of the first image capturing device is set to a reference.

[0187] <<Seventh modified example>>

The present embodiment has exemplified the case where the identification information acquisition unit 1210 includes the recognition unit 1202, the obtainment unit 1203, the collation unit 1204, and the specification unit 1205. However, the identification information acquisition unit 1210 does not always have to include the recognition unit 1202, the obtainment unit 1203, the collation unit 1204, and the specification unit 1205, as long as it acquires the identification information of the plate to be associated with the three-dimensional position derived by the position derivation unit 1206. The identification information acquisition unit 1210 may

also include only the recognition unit 1202, for example. Further, the identification information acquisition unit 1210 may also include only the obtainment unit 1203, for example. Further, the identification information acquisition unit 1210 may also include only the recognition unit 1202 and the obtainment unit 1203, for example. For instance, the identification information acquisition unit 1210 may also acquire an ID recognized by the recognition unit 1202 as the identification information of the plate. In this case, it is possible that the identification information acquisition unit 1210 does not include the obtainment unit 1203, the collation unit 1204, and the specification unit 1205. Further, for example, when an article to be a management target of position is previously limited to one, the identification information acquisition unit 1210 may acquire an ID obtained by the obtainment unit 1203, as the identification information of the plate. In this case, it is possible that the identification information acquisition unit 1210 does not include the recognition unit 1202, the collation unit 1204, and the specification unit 1205. Further, when specifying the plate only from the information recognized by the recognition unit 1202, the identification information acquisition unit 1210 may use the recognition unit 1202, and when the article to be the management target of position is previously limited to one, the identification information

acquisition unit 1210 may use the obtainment unit 1203, for example. In this case, it is possible that the identification information acquisition unit 1210 does not include the collation unit 1204 and the specification unit 1205 (the identification information acquisition unit 1210 may include only the recognition unit 1202 and the obtainment unit 1203).

[0188] <<Eighth modified example>>

The present embodiment has exemplified the case where the management table 1300 is stored in the article management device 1200. However, the management table 1300 may also be provided outside the article management device 1200.

[0189] <<Ninth modified example>>

The present embodiment has exemplified the case where the article whose existing position changes is the plate. However, the article whose existing position changes is not limited to the plate. For example, the article whose existing position changes may also be a manufactured product other than the plate. The article whose existing position changes may also be a manufactured product on which information managed by a manufacturer is displayed. The manufactured product may be, for example, a slab, a billet, a sheet coil, or a steel pipe. Further, the article may be one other than the manufactured product. The article whose existing position changes may be a container, for example.

[0190] (Second embodiment)

Next, a second embodiment will be described. The first embodiment has exemplified the case where the article management device 1200 manages the position of the article whose existing position changes. The present embodiment will describe a case where the article management device 1200 manages a position of an article installed in an installation target region. As above, in the present embodiment, the article being the management target of position is set to be an article whose existing position is not supposed to change. As described above, the present embodiment and the first embodiment are different mainly in the configuration and the processing due to the difference regarding that the existing position of the article being the management target of position is supposed to change or not. Therefore, in the description of the present embodiment, parts same as those of the first embodiment will be denoted by the same reference numerals as those denoted in Fig. 1 to Fig. 21, and detailed description thereof will be omitted.

[0191] As articles to be managed by the article management device 1200 of the present embodiment, there are articles illustrated in Fig. 22 and Fig. 23, for example.

[0192] Fig. 22 is a view illustrating an example of steel frames of a structure installed on the ground. In the example illustrated in Fig. 22, an

installation target region is the ground. The structure is, for example, a building and a bridge. Note that in Fig. 22, only a part of steel frames of the structure is illustrated in a simplified manner, in order to simplify the notation. Further, Fig. 22 exemplifies a case where, on surfaces of structural materials 2201a and 2201b to be beam members out of structural materials 2201a to 2201d configuring the steel frames of the structure installed on the ground, IDs 2202a and 2202b are displayed as information for uniquely identifying the structural materials 2201a and 2201b. Note that the structural material is, for example, a metal material such as a steel material. The structural materials 2201a and 2201b are H-shaped steels. The IDs 2202a and 2202b are pieces of information corresponding to the IDs 305 and 312. The IDs 2202a and 2202b are displayed by at least any one of stencil, handwriting, and a die stamp, for example. Further, the IDs 2202a and 2202b may also be displayed by labels. Further, information other than the IDs 2202a and 2202b may also be displayed on the surfaces of the structural materials 2201a and 2201b.

[0193] Further, Fig. 22 exemplifies a case where the IDs 2202 are displayed only on the structural materials 2201a and 2201b out of the structural materials 2201a to 2201d, in order to simplify the notation. However, also on surfaces of the structural materials 2201c and 2201d, information

including information (IDs) for uniquely identifying the structural materials 2201c and 2201d may also be displayed. Further, Fig. 22 exemplifies a case where joining between the structural material 2201a and the structural materials 2201c and 2201d, and joining between the structural material 2201b and the structural materials 2201c and 2201d are performed by welding, respectively. However, the joining method of the structural materials 2201a to 2201d is not limited to the method by welding. For example, the two structural materials may also be joined by using splice plates.

[0194] In the example illustrated in Fig. 22, in a period from when the structural materials 2201a and 2201b are installed to when the surfaces of the structural materials 2201a and 2201b disappear from sight due to painting of the structural materials 2201a and 2201b or the like, a captured image of a region of the structural materials 2201a and 2201b including the IDs 2202a and 2202b is captured by using a first image capturing device. As above, after the installation, the IDs 2202a and 2202b (information for uniquely identifying articles) are hidden and thus disappear from sight. The role of the first captured image is the same as that of the first captured image described in the first embodiment. As the first image capturing device, a first image capturing device held by an operator (worker), for example, is used. Further, as the

first image capturing device, it is also possible to use a first image capturing device provided to an unmanned aircraft (drone). Note that in the description below, the region of the structural materials 2201a and 2201b including the IDs 2202a and 2202b will be referred to as an ID display region of the structural material, according to need. The ID display region of the structural material corresponds to the display region by the stencil (label) in the first embodiment.

[0195] Fig. 23 is a view illustrating an example of a pipe installed in the ground. In the example illustrated in Fig. 23, an installation target region is the underground. The pipe is, for example, at least one of a metal pipe, an earthen pipe, a polyvinyl chloride pipe, and an insulating pipe. Fig. 23 exemplifies a case where, on a surface of a pipe 2301a out of pipes 2301a to 2301c installed in the ground, an ID 2302 is displayed as information for uniquely identifying the pipe 2301a. The ID 2302 is information corresponding to the IDs 305 and 312. The ID 2302 is displayed by at least any one of stencil, handwriting, and a die stamp, for example. Further, the ID 2302 may also be displayed by a label. Further, as described in the first embodiment, information other than the ID 2302 may also be displayed on the surface of the pipe 2301a.

[0196] Note that Fig. 23 exemplifies a case where the ID 2302 is displayed only on the pipe 2301a out

of the pipes 2301a to 2301c, in order to simplify the notation. However, also on surfaces of the pipes 2301b and 2301c, information including information (IDs) for uniquely identifying the pipes 2301b and 2301c may also be displayed. Further, Fig. 23 exemplifies a case where the pipes 2301a to 2301c are joined by using joint members 2303a and 2303b. However, the joining method of the pipes 2301a to 2301c is not limited to the method using the joint members 2303a and 2303b.

[0197] In the example illustrated in Fig. 23, in a period from when the pipe 2301a is installed to when a hole 2304 is filled up, which makes the pipes 2301a to 2301c disappear from sight, a captured image of a region of the pipe 2301a including the ID 2302 is captured by using a first image capturing device. As above, after the installation, the ID 2302 (information for uniquely identifying an article) is hidden and thus disappears from sight. The role of the first captured image is the same as that of the first captured image described in the first embodiment. As the first image capturing device, a first image capturing device held by an operator (worker), for example, is used. Further, as the first image capturing device, it is also possible to use a first image capturing device provided to an unmanned aircraft (drone). Note that in the description below, the region of the region of the pipe 2301a including the ID 2302 will be referred to

as an ID display region of the pipe, according to need. The ID display region of the pipe corresponds to the display region by the stencil (label) in the first embodiment.

[0198] An example of a functional configuration of the article management device 1200 of the present embodiment is the same as an example of the functional configuration of the article management device 1200 of the first embodiment illustrated in Fig. 12.

[0199] Further, an example of a management table to be managed by the article management device 1200 of the present embodiment, is a management table 2400 illustrated in Fig. 24. Note that in the description below including the drawings, when the article management device 1200 (the storage unit 1207) manages positions of the structural materials (the structural materials 2201a and 2201b, and the like), it stores information used for managing the positions of the structural materials (the structural materials 2201a and 2201b, and the like) in the management table 2400. When the article management device 1200 (the storage unit 1207) manages the positions of the structural materials (the structural materials 2201a and 2201b, and the like), it does not have to store information used for managing the positions of the pipes (the pipe 2301a, and the like) in the management table 2400. On the other hand, when the article management device 1200 (the storage unit

1207) manages the positions of the pipes (the pipe 2301a, and the like), it stores the information used for managing the positions of the pipes (the pipe 2301a, and the like) in the management table 2400. When the article management device 1200 (the storage unit 1207) manages the positions of the pipes (the pipe 2301a, and the like), it does not have to store the information used for managing the positions of the structural materials (the structural materials 2201a and 2201b, and the like) in the management table 2400. Further, similarly to Fig. 13, also in Fig. 24, information on the same column corresponds to identification information with respect to the same structural material (pipe) (sections below the same No. are sections in which pieces of identification information with respect to the same structural material (pipe) are respectively stored). In the description below including the drawings, the structural materials (the structural materials 2201a and 2201b, and the like) and the pipes (the pipe 2301a, and the like) will be referred to as a position-fixed article, according to need.

[0200] Further, a flow chart explaining an example of processing performed by the article management device 1200 of the present embodiment, is a flow chart illustrated in Fig. 25. Note that a flow chart that explains an example of processing performed by the article management device 1200 when managing a position of a structural material, and a flow chart

that explains an example of processing performed by the article management device 1200 when managing a position of a pipe, are different flow charts. When the flow chart illustrated in Fig. 25 is the flow chart that explains an example of processing performed by the article management device 1200 when managing the position of the structural material, the "position-fixed article" in Fig. 25 means the "structural material". When the flow chart illustrated in Fig. 25 is the flow chart that explains an example of processing performed by the article management device 1200 when managing the position of the pipe, the "position-fixed article" in Fig. 25 means the "pipe".

[0201] Fig. 22 and Fig. 23 exemplify the cases where only the IDs 2202a and 2202b, and 2302 are displayed on the structural materials 2201a and 2201b, and the pipe 2301a, respectively. Therefore, in the section of actual article display in the management table 2400 illustrated in Fig. 24, only the section of ID in which the IDs 2202a and 2202b, and 2302 are stored, is indicated. However, when information other than the IDs 2202a and 2202b, and 2302 is displayed on the structural materials 2201a and 2201b, and the pipe 2301a, a section in which the information is stored may be included in the section of actual article display in the management table 2400.

[0202] In a section of article position in the management table 2400, information indicating a

three-dimensional position of the position-fixed article is stored. The information stored in the section of article position is information indicating the three-dimensional position of the position-fixed article specified by the article management device 1200. The present embodiment exemplifies a case where a three-dimensional position of the ID display region of the structural material and a three-dimensional position of the ID display region of the pipe are a three-dimensional position of the structural material and a three-dimensional position of the pipe, respectively. Further, in the present embodiment, the three-dimensional position of the ID display region of the structural material and the three-dimensional position of the ID display region of the pipe are an example of information display positions.

[0203] In a section of registration time in the management table 2400, information indicating date and time (a timing defined by date and time) at which the position-fixed article was placed at the current position is stored. Note that the date and time at which the position-fixed article was placed at the current position is set to indicate the date and time at which the action for acquiring the date and time was performed. In the section of registration time, for example, the date and time of capturing a first captured image are stored. However, the information that is stored in the section of registration time is

not limited to the date and time of capturing the first captured image (it is set that this similarly applies to the first embodiment as well). For example, an operator may input the information regarding the date and time at which the position-fixed article was placed at the current position in the article management device 1200, by operating the user interface of the article management device 1200. In the present embodiment, the information stored in the section of registration time is an example of the date and time at which the action for acquiring the date and time at which the article was placed at the current position, was performed.

[0204] As described above, the IDs 2202a and 2202b displayed on the structural materials 2201a and 2201b disappear from sight due to painting or the like. Further, the ID 2302 displayed on the pipe 2301a disappears from sight by being buried in the ground. Even in such a case, an operator can figure out an elapsed time from when the position-fixed article was installed, based on the information stored in the section of registration time. Therefore, it is possible to judge whether or not repair or replacement of the position-fixed article is required, based on the elapsed time from when the position-fixed article was installed, for example. Further, based on the information stored in the section of ID and the section of article position, it is possible to figure out which position-fixed article exists at

which position, regardless of whether or not the IDs 2202a and 2202b, and 2302 are in a visually recognizable state. Therefore, it is possible to figure out what kind of the position-fixed article is required to perform repair or replacement, and at which position the position-fixed article exists. Therefore, it is possible to make use of the information stored in the management table 2400 for repair and replacement of a position-fixed article in a state where its ID (information for uniquely identifying the article) cannot be visually recognized, for example.

[0205] Note that in the section of non-actual article display in the management table 2400, a section other than the section of article position and the section of registration time may also be included. For example, in the section of non-actual article display in the management table 2400, a section of position in article and a section of parent ID may also be stored, similarly to the management table 1300 of the first embodiment. Note that the first embodiment has exemplified the case where the position in article is the position at which the predetermined position (the vertex 203 or 204) in the plate is set to the origin. A mark indicating the origin may also be displayed at a predetermined position on a surface of the position-fixed article. The mark is displayed by using paint, for example. Further, a straight line parallel to a

symmetry axis (center axis) of the position-fixed article may also be displayed on the surface of the position-fixed article. The straight line is displayed by using paint, for example. In such a case, the first image capturing device captures a first captured image including an ID display region of the position-fixed article, the mark, and the straight line. In such a case, a position at which the mark-displayed position is set to an origin, corresponds to a position in article. Further, the straight line corresponds to the y-axis illustrated in Fig. 14 and Fig. 15. Note that a straight line corresponding to the x-axis illustrated in Fig. 14 and the z-axis illustrated in Fig. 15 may also be displayed on the surface of the position-fixed article. Further, regarding the pipe, it is set that a distance from the origin in the x-axis illustrated in Fig. 14 and the z-axis illustrated in Fig. 15 can be determined by taking a curvature in accordance with an outside diameter of the pipe into consideration.

[0206] Further, in the section of non-actual article display in the management table 2400, the section of article direction described in the <<fifth modified example>> of the first embodiment may also be included. Note that a pipe does not have a plate surface. Therefore, an angle made by a symmetry axis (center axis) of the pipe and a reference plane, for example, is stored in the section of article

direction. In such a case, for example, the ID 2302 is set to be displayed on the surface of the pipe 2301a so that a direction in which a plurality of components ("4312" in the example illustrated in Fig. 23) are arranged becomes a previously determined direction (for example, a direction parallel to a symmetry axis (center axis) of the pipe 2301a).

[0207] Further, when the ID of the position-fixed article and the three-dimensional position of the position-fixed article are specified from a design drawing, a section of assumed article position, separately from the article position, may also be included in the section of non-actual article display in the management table 2400. In the section of assumed article position, a three-dimensional position of the position-fixed article specified from the design drawing is stored.

[0208] In the first embodiment, the first image acquisition unit 1201, the recognition unit 1202, the obtainment unit 1203, the collation unit 1204, the specification unit 1205, the position derivation unit 1206, the storage unit 1207, the output unit 1208, and the second image acquisition unit 1209 perform the processing using the display region by the stencil (label). On the contrary, in the present embodiment, the first image acquisition unit 1201, the recognition unit 1202, the obtainment unit 1203, the collation unit 1204, the specification unit 1205, the position derivation unit 1206, the storage unit

1207, the output unit 1208, and the second image acquisition unit 1209 perform the processing using the ID display region of the structural material and the ID display region of the pipe.

[0209] Therefore, in the present embodiment, the specification unit 1205 specifies, in step S2505 in Fig. 25, one position-fixed article from the position-fixed articles managed in the management table 2300, based on the result of collation in step S2504.

[0210] Further, in the present embodiment, the position derivation unit 1206 derives the three-dimensional position of the position-fixed article installed in the installation target region. Therefore, for example, when it is possible to previously suppose that which position-fixed article is to be installed at which position, based on the design drawing, the determination in step S2508 in Fig. 25 may not be executed. In such a case, the article management device 1200 may not include the second image acquisition unit 1209.

[0211] Further, in step S2509, the position derivation unit 1206 may also derive the three-dimensional position of the position-fixed article by using the mathematical formula expressing the geometrical positional relationship between the ID display region of the position-fixed article and the first image capturing device, similarly to the first embodiment. Note that the mathematical formula

expressing the geometrical positional relationship between the ID display region of the pipe and the first image capturing device is expressed by using a curvature of the surface of the pipe. Further, it is also possible to derive a three-dimensional positional relationship between the ID display region of the position-fixed article and the first image capturing device by using information (dimensions) of the ID display region of the position-fixed article and information of the first image capturing device (the number of pixels and the size of the image capturing sensor, and the focal distance). Note that as described in the first embodiment, when deriving the three-dimensional positional relationship between the ID display region of the pipe and the first image capturing device, the shape and the dimensions of the ID display region of the pipe, and the curvature of the surface of the pipe are used as the information of the ID display region of the position-fixed article. Further, the three-dimensional position of the position-fixed article may also be derived by using the luminance image and the distance image.

[0212] Further, the position derivation unit 1206 may also determine whether or not a difference between the three-dimensional position of the position-fixed article derived as above and the three-dimensional position stored in the section of assumed article position in the section of non-actual article display in the management table is within a

predetermined range. In this case, it is possible to design such that processing in step S2512 is performed when the difference between the three-dimensional position of the position-fixed article derived as above and the three-dimensional position stored in the section of assumed article position in the section of non-actual article display in the management table is not within the predetermined range.

[0213] Further, the position derivation unit 1206 may also perform the following processing in step S2509. Specifically, the position derivation unit 1206 may also derive the three-dimensional position stored in the section corresponding to the position-fixed article specified in step S2505, in the section of assumed article position in the section of non-actual article display in the management table, as the three-dimensional position of the position-fixed article specified in step S2505. However, if it is set that the three-dimensional position of the position-fixed article is derived in a manner as above, in the case where the position-fixed article is not installed at a designed position, an accurate position may not be derived as the three-dimensional position of the position-fixed article. Therefore, if it is set that the three-dimensional position of the position-fixed article is derived in a manner as above, a worker (operator) preferably confirms, based on information indicating the three-dimensional

position of the position-fixed article output in S2511, whether the position-fixed article is installed at the three-dimensional position.

[0214] Further, in the present embodiment, the position derivation unit 1206 derives the three-dimensional position of the position-fixed article installed in the installation target region. Therefore, after the derivation of the three-dimensional position of the position-fixed article by the position derivation unit 1206 in step S2509, the three-dimensional position of the position-fixed article does not always have to be updated. Because of this, the "update" indicated in steps S1710 and S1713 in Fig. 17 is changed to "store" in steps S2510 and S2513 in Fig. 25. However, after the derivation of the three-dimensional position of the position-fixed article by the position derivation unit 1206 in step S2509, the three-dimensional position of the position-fixed article may also be updated. For example, when, based on the information indicating the three-dimensional position of the position-fixed article output in step S2511, the three-dimensional position is apparently different from the actual three-dimensional position, the worker (operator) may instruct the article management device 1200 to derive the three-dimensional position of the position-fixed article again. In this case, the processing according to the flow chart in Fig. 25 is executed again, and the three-dimensional position of the

position-fixed article may be updated in step S2510.

[0215] As described above, in the present embodiment, the article management device 1200 acquires the first captured image including the display region being the information displayed on the position-fixed article installed on the ground or in the ground and on which the ID managed by the manufacturer of the position-fixed article is displayed. The article management device 1200 derives, based on the acquired first captured image, and the position of the first image capturing device that captured the first captured image, the three-dimensional position of the ID display region of the position-fixed article, and stores the information indicating the three-dimensional position in the storage medium while associating the information with the ID of the position-fixed article. Therefore, for example, even in a case where it becomes realistically impossible to confirm the information displayed on the position-fixed article after the installation of the position-fixed article, it is possible to manage that which position-fixed article exists at which position. Therefore, it is possible to properly manage the position of the position-fixed article installed in the installation target region.

Note that the article installed in the installation target region is not limited to the structural material illustrated in Fig. 22 and the pipe illustrated in Fig. 23. Further, the present

embodiment may also employ the various modified examples described in the first embodiment.

[0216] <<Other modified examples>>

Note that the embodiments of the present invention described above can be realized when a computer executes a program. Further, a computer-readable recording medium recording the program and a computer program product, for example, the program can also be applied as embodiments of the present invention. As the recording medium, it is possible to use, for example, a flexible disk, a hard disk, an optical disk, a magneto-optical disk, a CD-ROM, a magnetic tape, a nonvolatile memory card, a ROM, or the like. Further, the embodiments of the present invention may be realized by PLC (Programmable Logic Controller), or dedicated hardware, for example, ASIC (Application Specific Integrated Circuit).

It should be noted that the embodiments of the present invention described above merely illustrate concrete examples of implementing the present invention, and the technical scope of the present invention is not to be construed in a restrictive manner by these embodiments. That is, the present invention may be implemented in various forms without departing from the technical spirit or main features thereof.

[0217] (Hardware)

One example of hardware of the article management device 1200 will be described. In Fig. 26, the

article management device 1200 includes a CPU 2601, a main memory 2602, an auxiliary memory 2603, a communication circuit 2604, a signal processing circuit 2605, an image processing circuit 2606, an I/F circuit 2607, a user interface 2608, a display 2609, and a bus 2610.

[0218] The CPU 2601 totally controls the entire article management device 1200. The CPU 2601 uses the main memory 2602 as a work area, to thereby execute a program stored in the auxiliary memory 2603. The main memory 2602 stores data temporarily. The auxiliary memory 2603 stores various kinds of data, in addition to the program executed by the CPU 2601. Note that a processor other than the CPU (GPU, for example) may also be used.

[0219] The communication circuit 2604 is a circuit for performing communication with the outside of the article management device 1200. The communication circuit 2604 may perform wireless communication or wire communication with the outside of the article management device 1200.

[0220] The signal processing circuit 2605 performs various kinds of signal processing on a signal received by the communication circuit 2604 or a signal input in accordance with the control by the CPU 2601.

The image processing circuit 2606 performs various kinds image processing on a signal input in accordance with the control by the CPU 2601. The

signal after being subjected to this image processing is output to the display 2609, for example.

The user interface 2608 is a part with which an operator issues instructions to the article management device 1200. The user interface 2608 includes, for example, a button, a switch, a dial, and the like. Further, the user interface 2608 may include a graphical user interface that uses the display 2609.

[0221] The display 2609 displays an image based on the signal output from the image processing circuit 2606. The I/F circuit 2607 exchanges data with a device connected to the I/F circuit 2607. In Fig. 26, the user interface 2608 and the display 2609 are indicated as the devices connected to the I/F circuit 2607. However, the device connected to the I/F circuit 2607 is not limited to these. For example, a portable storage medium may be connected to the I/F circuit 2607. Further, at least a part of the user interface 2608 and the display 2609 may also be provided outside the article management device 1200.

The output unit 1208 is realized by using, for example, the communication circuit 2604 and the signal processing circuit 2605, and at least any one of the image processing circuit 2606, the I/F circuit 2607, and the display 2609.

[0222] Note that the CPU 2601, the main memory 2602, the auxiliary memory 2603, the signal processing circuit 2605, the image processing circuit 2606, and

the I/F circuit 2607 are connected to the bus 2610. The communication among these components is performed via the bus 2610. Further, the hardware of the article management device 1200 is not limited to one illustrated in Fig. 26, as long as it is possible to realize the above-described functions of the article management device 1200.

INDUSTRIAL APPLICABILITY

[0223] The present invention can be used for managing a position of an article, for example.

CLAIMS

[Claim 1] An article management device that manages a position of an article, comprising:

one or two or more of image acquisition units each of which acquires a captured image of a region including display information displayed on the article;

an identification information acquisition unit that acquires identification information of the article;

a position derivation unit that derives, based on the captured image acquired by the image acquisition unit, an information display position being a three-dimensional position at which the display information is displayed; and

a storage unit that stores the information display position in the article derived by the position derivation unit, in a storage medium in association with the identification information of the article acquired by the identification information acquisition unit.

[Claim 2] The article management device according to claim 1, wherein:

the display information displayed on the article includes the identification information of the article; and

the identification information acquisition unit includes at least one of:

a recognition unit that recognizes the

identification information of the article based on the captured image acquired by the image acquisition unit; and

an obtainment unit that obtains the identification information of the article stored in the storage unit.

[Claim 3] The article management device according to claim 2, wherein:

the information display position stored in the storage medium in association with the identification information of the article includes, as information regarding the three-dimensional position at which the display information is displayed, information regarding a three-dimensional position in a case where a predetermined position of the article is set to a reference; and

the captured image acquired by the image acquisition unit includes a region including the predetermined position of the article.

[Claim 4] The article management device according to claim 2 or 3, wherein

the identification information acquisition unit includes:

the recognition unit;

the obtainment unit;

a collation unit that collates the identification information of the article recognized by the recognition unit with the identification information of the article obtained by the obtainment unit; and

a specification unit that specifies, based on a result of collation by the collation unit, the identification information of the article included in the captured image acquired by the image acquisition unit.

[Claim 5] The article management device according to any one of claims 1 to 4, wherein

the position derivation unit derives a position in a height direction of a surface of the article on which the display information is displayed, based on two or more of captured images acquired by two or more of the image acquisition units.

[Claim 6] The article management device according to any one of claims 1 to 5, wherein

the storage unit stores the information display position in the article derived by the position derivation unit in the storage medium as a current position of the article, and stores date and time at which the article was placed at the current position in the storage medium in association with the information display position in the article.

[Claim 7] The article management device according to any one of claims 1 to 6, wherein:

the article management device manages a position of an article whose existing position changes; and

when, in a case where the information display position in the article and the identification information of the article are already stored in the storage medium in a mutually associated manner, the

information display position in the article is newly derived by the position derivation unit, the storage unit updates the information display position that is already stored in the storage medium to the information display position newly derived by the position derivation unit.

[Claim 8] The article management device according to any one of claims 1 to 6, wherein

the article management device manages a position of an article installed in an installation target region.

[Claim 9] An article management method of managing a position of an article, comprising:

one or two or more of image acquisition steps of acquiring a captured image of a region including display information displayed on the article;

an identification information acquisition step of acquiring identification information of the article;

a position derivation step of deriving, based on the captured image acquired by the image acquisition step, an information display position being a three-dimensional position at which the display information is displayed; and

a storage step of storing the information display position in the article derived by the position derivation step, in a storage medium in association with the identification information of the article acquired by the identification information acquisition step.

[Claim 10] A data structure of article management data, comprising:

display information displayed on an article; and

non-display information that is not displayed on the article, wherein:

the non-display information includes an information display position being a three-dimensional position at which the display information is displayed; and

the data structure of the article management data is used for deriving, by an article management device, the information display position in the article based on a captured image of a region including the display information displayed on the article.

[Claim 11] A program for making a computer execute processing of managing a position of an article, the program making the computer execute:

one or two or more of image acquisition steps of acquiring a captured image of a region including display information displayed on the article;

an identification information acquisition step of acquiring identification information of the article;

a position derivation step of deriving, based on the captured image acquired by the image acquisition step, an information display position being a three-dimensional position at which the display information is displayed; and

a storage step of storing the information display position in the article derived by the position

derivation step, in a storage medium in association with the identification information of the article acquired by the identification information acquisition step.