

DIMENSION MEASUREMENT DEVICE FOR HOME DELIVERY BOX

TECHNICAL FIELD

[0001]

5 The present disclosure relates to a dimension measurement device for a home delivery box.

BACKGROUND

[0002]

10 Conventionally, as disclosed in Patent Literature 1, there is known a home delivery box which includes a plurality of storage chambers (storage units) and is placed at a public place where it can be used by an unspecified people. Such a home delivery box can be used by an unspecified large number of people for sending home delivery articles. When a sender puts a home delivery article into the storage unit of the measurement device for
15 the home delivery box, dimensions of the home delivery article are measured by the dimension measurement device. Thereby, of two sizes of the home-delivery-article retaining units, the optimum home-delivery-article retaining unit is selected and a door thereof opens automatically. The sender retains the home delivery article in the home-delivery-article retaining unit.

20 [0003]

 Patent Literature 2 discloses a device which measures dimensions of a to-be-measured object such as a home delivery article, and which includes: a storage chamber that stores the to-be-measured object; an imaging unit that captures an image inside the storage chamber; and an image processing unit that measures the dimensions of the to-be-
25 measured object by performing image processing on the basis of information of the image captured by the imaging unit.

CITATION LIST

PATENT LITERATURE

[0004]

Patent Literature 1: JP2017-116482 A

Patent Literature 2: JP2017-150908 A

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SUMMARY

TECHNICAL PROBLEM

[0005]

According to the dimension measurement device disclosed in Patent Literature 2,
10 the dimensions of the to-be-measured object may be automatically measured from the
image captured by the imaging unit. However, with such a dimension measurement
device, it is necessary to place the to-be-measured object at a predetermined specific
position within the storage chamber in order to make it possible to measure the dimensions
of the to-be-measured object. Specifically, it is necessary to set a reference corner part in
15 the storage chamber, and to place the to-be-measured object such that three side surfaces of
the to-be-measured object are almost in contact with a lower-surface part, a first side-
surface part, and a second side-surface part intersecting with each other at the reference
corner part. Meanwhile, if the to-be-measured object is placed in the storage chamber
while being misaligned from the specific position, the dimensions of the to-be-measured
20 object may not be measured with high precision.

[0006]

It is an advantage of the present disclosure to provide a dimension measurement
device for a home delivery box capable of measuring dimensions of a to-be-measured
object stored in a storage chamber with high precision.

25 SOLUTION TO PROBLEM

[0007]

The dimension measurement device for a home delivery box according to the
present disclosure includes: a storage chamber in which a to-be-measured object is stored

in such a manner as to be capable of being taken in and out of the storage chamber; an imaging unit which captures an image of the to-be-measured object to be stored in the storage chamber; an image processing unit which measures dimensions of the to-be-measured object by performing image processing thereon on the basis of information of the image captured by the imaging unit and which detects, on the basis of the image information, presence or absence of positional misalignment from a predetermined specific position for the to-be-measured object; and a notification unit which, in a case when the positional misalignment has been detected by the image processing unit, issues notification of inquiry as to whether or not the to-be-measured object is to be repositioned.

10 ADVANTAGEOUS EFFECTS OF INVENTION

[0008]

According to the dimension measurement device for a home delivery box according to the present disclosure, when the to-be-measured object is misaligned from the specific position while being placed in the storage chamber, the notification unit issues the notification of inquiry as to whether or not the to-be-measured object is to be repositioned. In response to that notification, the user is allowed to reposition the to-be-measured object until there is no such notification, so that the dimension measurement device may be able to measure the dimensions of the to-be-measured object placed accurately at the specific position with high precision.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a perspective view of a home delivery box that includes a dimension measurement device according to an embodiment of the present disclosure.

25 FIG. 2 is a perspective view showing an example of a storage chamber of the dimension measurement device.

FIG. 3 is a block diagram showing the dimension measurement device according to the embodiment of the present disclosure.

FIG. 4 is a flowchart showing detection of positional misalignment and measurement of the dimensions according to the embodiment.

FIG. 5(a) is a diagram showing a binary image based on an image for measurement which is captured by an imaging unit, in a state where a to-be-measured object is disposed in the storage chamber, and (b) is a diagram showing a corrected image based on the
5 binary image shown in (a).

FIG. 6 is a diagram showing four kinds of scanning-line directions for measuring the dimensions in the corrected image when the to-be-measured object is disposed at a specific position of the storage chamber.

FIG. 7(a) is a chart showing a first height graph that shows changes in the length of first scanning lines shown in FIG. 6, Fig. 7(b) is a chart showing a second height graph that shows changes in the length of second scanning lines shown in FIG. 6, Fig. 7(c) is a chart showing a width graph that shows changes in the length of third scanning lines shown in FIG. 6, and Fig. 7(d) is a chart showing a depth graph that shows changes in the length of
10 fourth scanning lines shown in FIG. 6.
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FIG. 8 is a diagram showing a first example of detection of positional misalignment when the to-be-measured object is disposed at a position misaligned from the specific position in the storage chamber, and is a diagram corresponding to FIG. 6.

FIG. 9 is a chart showing a depth graph that shows changes in the length of fourth scanning lines shown in FIG. 8.
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FIG. 10 is a diagram showing a second example of detection of positional misalignment when the to-be-measured object is disposed at a position misaligned from the specific position in the storage chamber, and is a diagram corresponding to FIG. 6.

FIG. 11(a) is a chart showing a first height graph that shows changes in the length of first scanning lines shown in FIG. 10, and Fig. 11(b) is a chart showing a second height graph that shows changes in the length of second scanning lines shown in FIG. 10.
25

FIG. 12 is a drawing showing a method for detecting positional misalignment when the to-be-measured object is disposed obliquely with respect to a first side-surface part and

a second side-surface part at a position misaligned from the specific position in the storage chamber, and is a diagram corresponding to FIG. 6.

FIG. 13 is a chart showing a depth graph that shows changes in the length of fourth scanning lines shown in FIG. 12.

5 FIG. 14 is a perspective view of a home delivery box according to another example of the embodiment.

FIG. 15 is a perspective view showing a storage chamber of a dimension measurement device according to another example of the embodiment.

FIG. 16 is a flowchart showing a procedure for generating an image for
10 measurement for measuring dimensions according to another example of the embodiment.

FIG. 17 is a diagram showing an image without a package (image A) generated by the procedure of generating the image for measurement for measuring the dimensions according to another example of the embodiment.

FIG. 18 is a diagram showing an image with a package (image B) generated by the
15 procedure of generating the image for measurement for measuring the dimensions according to another example of the embodiment.

FIG. 19 is a diagram showing an image (image C) generated from a difference between the image of FIG. 17 and the image of FIG. 18.

FIG. 20 is a diagram showing a method for detecting edges from images of each of
20 three surfaces within the storage chamber in the image of FIG. 19.

FIG. 21 is a diagram in which the edges detected in FIG. 20 are emphasized.

FIG. 22 is a diagram showing an enlarged view of the image in the vicinity of the package in FIG. 21.

25 DESCRIPTION OF EMBODIMENTS

[0010]

Hereinafter, an embodiment of the present disclosure will be described by referring to the accompanying drawings. The shapes and the number described hereinafter are

examples used for description, and can be changed as appropriate according to specifications of a home delivery box including a dimension measurement device. The same reference signs are applied to equivalent elements in all the drawings hereinafter for description. Further, in the description of the present disclosure, the reference signs
5 described theretofore are to be used as necessary.

[0011]

In the description and the drawings hereinafter, "R" is the right side when facing toward the home delivery box, "L" is the left side in the same way, "F" is the front side of the home delivery box, and "B" is the rear side of the home delivery box. The direction
10 connecting "R" to "L" and the direction connecting "F" to "B" are orthogonal to each other.

[0012]

FIG. 1 is a perspective view of a home delivery box 12 including a dimension measurement device 20 according to an embodiment of the present disclosure. The home delivery box 12 is placed at a public place where it can be used by an unspecified people,
15 so that an unspecified large number of people can use it for sending home delivery articles.

[0013]

As shown in FIG. 1, the home delivery box 12 includes a substantially cuboid exterior body (main body) 13, a plurality of home-delivery storage chambers 14, doors 15 for opening/closing openings of each of the home-delivery storage chambers 14, a
20 dimension measurement device 20, and an operation display unit 17. Hereinafter, the dimension measurement device 20 may also be written as a measurement device 20. The home-delivery storage chamber 14 is in a box shape in which a to-be-measured object 90 (FIG. 2) is stored in such a manner as to be capable of being taken in and out. In the embodiment, the to-be-measured object 90 is a home delivery article whose external shape
25 is cuboid.

[0014]

The door 15 closes the opening on the front side F of the home-delivery storage chamber 14. The door 15 is a single-swing type attached to the home delivery box 12,

which is capable of opening/closing the opening of the home-delivery storage chamber 14 by being oscillated about an axis in a top-and-bottom direction (not shown). The door 15 of the home-delivery storage chamber 14 is locked with an electric lock 18 (FIG. 3). The electric lock 18 is unlocked by a user operation or the like on the operation display unit 17 (FIG. 1) to be described later. Note that the electric lock 18 may be configured to be unlocked by utilizing a barcode, a QR code (R), transmission/reception of wireless signals with mobile terminals such as smartphones using Bluetooth (R), a touchless key using radio waves or infrared rays, an IC card, or an input via a numeric keypad, or the like.

[0015]

Further, a package sensor 19 (FIG. 3) is provided inside the home-delivery storage chamber 14. The package sensor 19 detects presence or absence of the package such as the home delivery article inside the corresponding home-delivery storage chamber 14. The package sensor 19 is formed with a strain gauge, for example. The strain gauge includes a metal resistance material, and the metal resistance material shrinks and a resistance value thereof is reduced when a compressive force is applied from outside. Detection information of the package sensor 19 is transmitted to a control device 30 (FIG. 3) of the home delivery box 12.

[0016]

The control device 30 detects presence or absence of a package from the weight of the package disposed inside the home-delivery storage chamber 14 based on the electric signal and, when a package is detected, converts the detection information to package detection information. The information detected by the package sensor 19 may be transmitted not to the control device 30 but to a package sensor control unit (not shown). In that case, the package sensor control unit converts the detection information of the package sensor 19 to the package detection information. The package sensor 19 may be a configuration that is provided inside the home-delivery storage chamber 14 and detects presence or absence of the package inside the home-delivery storage chamber 14 using an optical sensor such as an infrared sensor.

[0017]

The measurement device 20 includes: two measurement storage chambers 51 that are disposed neighboring each other in a left-and-right direction on a lower end part at the end of the left side L of the home delivery box 12; and doors 52 that close the openings on the front side F of the measurement storage chambers 51 in an openable/closeable manner. The configuration and function of the door 52 are the same as those of the door 15 of the home-delivery storage chamber 14. Further, as in the case of the home-delivery storage chamber 14, the package sensor 19 (FIG. 3) is also provided inside the measurement storage chamber 51. The door 52 of the measurement storage chamber 51 may be in a configuration that is left unlocked. The configuration of the measurement device 20 will be described later in detail.

[0018]

The operation display unit 17 is disposed on the upper side than the measurement device 20 on the front side F of the home delivery box 12. The operation display unit 17 is formed with a touch panel display or the like, and includes a function of receiving an input made by a user operation and a function of a display unit. Underneath the operation display unit 17, a payment unit 70 is disposed. The payment unit 70 settles payment with electronic money by transmitting/receiving wireless signals with an IC card held by the user, for example. Note that instead of the operation display unit 17, it is possible to employ a configuration that includes a display unit formed with a liquid crystal display (LCD) and an operation unit formed with a numeric keypad. Further, the payment unit 70 may be a configuration with which payment is settled by inputting an identification number and a password of a credit card on a numeric keypad.

[0019]

In a case where a sender of a home delivery article as a customer of a courier makes an order to send the home delivery article by using the home delivery box 12, it is conducted as follows. For example, when the sender selects "shipment" on the display unit from a menu screen displayed on the operation display unit 17 of the home delivery

box 12, the door 52 of the measurement device 20 automatically opens. When the sender stores the home delivery article in the measurement storage chamber 51 and closes the door 52, the measurement device 20 captures an image of the home delivery article using an imaging unit 23 (FIG. 3). Then, an image processing unit 32 (FIG. 3) detects presence or absence of positional misalignment of the home delivery article from a specific position determined in advance on the basis of the information of the image captured by the imaging unit 23. When it is detected that there is no positional misalignment, the measurement device 20 measures dimensions of the home delivery article on the basis of the information of the image captured by the imaging unit 23. The measurement results and the like of the dimensions measured by the measurement device 20 are displayed on the operation display unit 17.

[0020]

After inputting the address and the like of the destination by using the operation display unit 17, the sender takes out the home delivery article from the measurement storage chamber 51. Note that it is also possible to employ a configuration with which the sender can preregister the address and the like of the destination through an advance registration or the like made via the Internet, instead of using the operation display unit. Then, the sender selects one of the home-delivery storage chambers 14 by using the operation display unit 17. As a result, the door 15 of the selected home-delivery storage chamber 14 is unlocked and automatically opened, so that the sender stores the home delivery article in the home-delivery storage chamber 14. The fact that the home delivery article is stored in the home-delivery storage chamber 14 is detected by the package sensor 19. Thereafter, a shipping fee is displayed on the operation display unit 17, and the sender pays the shipping fee via the payment unit 70. While FIG. 1 shows a case where the home delivery box 12 includes the two measurement storage chambers 51, there may be a single measurement storage chamber 51 and a single door 52 for closing the opening thereof.

[0021]

When the payment for the home delivery article is settled, information of the request for shipping the home delivery article is notified from the home delivery box 12 to a terminal device of the courier, a terminal device of the sender, and a management server via a communication network. Then, the courier goes to the place where the home delivery box 12 is placed, opens the door 15 of the corresponding home-delivery storage chamber 14, takes out the home delivery article from the home-delivery storage chamber 14, and conducts delivery work to the destination.

[0022]

Next, the measurement device 20 will be described in detail. FIG. 2 is a perspective view illustrating an example of the measurement storage chamber 51. FIG. 3 is a block diagram of the measurement device 20. The measurement device 20 includes the above-described measurement storage chambers 51 and doors 52, imaging unit 23, and control device 30 (FIG. 3). The control device 30 includes the image processing unit 32 (FIG. 3). The image processing unit 32 includes a positional misalignment detection unit 33 (FIG. 3) to be described later.

[0023]

The measurement storage device 51 is in a box shape that stores a to-be-measured object 90 that is capable of being taken in and out. As described above, the opening on the front side F of the measurement storage chamber 51 is closed with the door 52. The door 52 of the measurement storage chamber 51 may be in a configuration that is locked and unlocked with an electric lock, and the electric lock is unlocked by a user operation or the like made on the operation display unit 17 (FIG. 1).

[0024]

The measurement storage chamber 51 is a cuboid-shaped space surrounded by a base plate part 53, a right-wall part 54, a left-wall part 55 and a back-wall part 56 as three wall parts, and a top plate part 57. The base plate 53, each of the wall parts 54, 55, 56, and the top plate part 57 are all in a rectangular shape. The upper surface of the base

plate part 53 is a lower-surface part 53a. The to-be-measured object 90 as a home delivery article is placed on the lower-surface part 53a.

[0025]

The right-wall part 54 is extended toward the upper side from the right end of the base plate part 53. The back-wall part 56 is extended toward the upper side from the back end of the base plate part 53. The left-wall part 55 is extended toward the upper side from the left end of the bottom wall part 53. The surface of the left-wall part 55 on the measurement storage chamber 51 side is a first side-surface part 55a. The surface of the back-wall part 56 on the measurement storage chamber 51 side is a second side-surface part 56a.

[0026]

The first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a intersect at a reference corner part 58. The reference corner part 58 is the position where the to-be-measured object 90 is pressed against when the to-be-measured object 90 is placed in the measurement storage chamber 51. In the measurement storage chamber 51, the to-be-measured object 90 is placed to be aligned with the reference corner part 58 so that the three surfaces that are the lower surface of the to-be-measured object 90 and the two neighboring side surfaces come in contact with the lower-surface part 53a, the first side-surface part 55a, and the second side-surface part 56a of the measurement storage chamber 51, respectively. The position of the to-be-measured object 90 in this state is the predetermined specific position for measuring the dimensions.

[0027]

In the inner surface of the measurement storage chamber 51, a rectangular-frame first marker 61, second marker 62, and third marker 63 are displayed in the peripheral edges with the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a, respectively. As will be described later, each of the markers 61, 62, and 63 is used for generating correction data for correcting distortion and the like of the external shape of the to-be-measured object 90 in a captured image. The first, second,

and third markers 61, 62, and 63 are in a similar figure with the rectangles defining the first side-surface part 55a, the second side surface 56a, and the lower-surface part 53a, respectively, and are displayed as little rectangles that are smaller than those rectangles. Each side of each of the markers 61, 62, and 63 is parallel to the corresponding side of the rectangles defining the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a.

[0028]

While the first, second, and third markers 61, 62, and 63 are in a same color tone, those markers may preferably be in a different color tone from each other. Note here that color tones mean the tones of colors such as brightness and saturation of colors.

[0029]

As shown in FIG. 3, the imaging unit 23 includes a camera main body 24 and an illumination device 25. The camera main body 24 is disposed facing obliquely downward from the end part on the right side R (right end part in FIG. 2) as the position opposing to the reference corner part 58 which is the corner part on the upper side on the opening side of the measurement storage chamber 51, for example, so as to capture the image of the to-be-measured object 90. As the camera main body 24, a CCD camera is used, for example. The camera main body 24 may also be a CMOS camera. Actions of the camera main body 24 are controlled by the control device 30, and the camera main body 24 captures the image of the to-be-measured object 90 stored in the measurement storage chamber 51. Information of the image captured by the camera main body 24 is transmitted to the control device 30. The image captured by the camera main body 24 may be a grayscale image or a color image. In the case of the color image, it may be converted into a grayscale image when performing image processing. The control device 30 can be disposed at the periphery of the top plate part 57 (FIG. 2) that forms the upper end of the measurement storage chamber 51, for example, or the operation display unit 17 of the home delivery box 12 shown in FIG. 1.

[0030]

The illumination device 25 is disposed integrally with the camera main body 24 by being adjacent to the camera main body 24 as part of the imaging unit 23 on the upper side of the measurement storage chamber 51. The illumination device 25 illuminates and brightens the inside of the measurement storage chamber 51, particularly the lower-side part. On/off operation of the illumination device 25 is controlled by the control device 30. As the illumination device 25, a white LED is used, for example. As the illumination device 25, a fluorescent lamp, a lightbulb, or other LEDs may also be used. Note that the dimension measurement device may be in a configuration in which an illumination device illuminating inside the measurement storage chamber 51 is disposed as a device different from the imaging unit 23.

[0031]

Further, in a state before the to-be-measured object 90 is disposed in the measurement storage chamber 51, the imaging unit 23 captures in advance an image of the lower-surface part 53a, the first side-surface part 55a, the second side-surface part 56a, and each of the markers 61, 62, and 63 to acquire an original image. Information of the original image is transmitted to the control device 30 to be described later, and stored in a memory unit 35 of the control device 30. The original image is used in a correction mode to be described later.

[0032]

As shown in FIG. 3, the control device 30 includes a calculation processing unit 31 configured with an MCU (Micro Controller Unit), for example, and the memory unit 35. The memory unit 35 may be a RAM, a ROM, or the like. The calculation processing unit 31 includes a function of reading out and executing a program and the like stored in advance in the memory unit 35. The memory unit 35 includes a function of temporarily storing the read-out program and processing data, and a function of storing in advance a control program, a prescribed threshold value, and the like.

[0033]

The main functions of the device, system, or method of the present disclosure are achieved by execution of the program by the control device 30. Any types can be used as the calculation processing unit 31 as long as the functions can be achieved by executing the program. For example, the calculation processing unit may be a CPU. The calculation
5 processing unit may be formed with a single or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or LSI (large scale integration). A plurality of electronic circuits may be integrated on a single chip or may be provided in a plurality of chips. A plurality of chips may be integrated in a single device or may be provided in a plurality of devices. As the memory unit, a non-transitory recording medium such as an
10 optical disc or a hard disk drive may also be used. An external memory device may be connected to the control device 30 as the memory unit. The program may be stored in advance in a recording medium or may be supplied to the recording medium via a wide area network including the Internet or the like.

[0034]

15 The control device 30 also includes an interface 36. The operation display unit 17 (FIG. 1) is connected to the calculation processing unit 31 via the interface 36. To the calculation processing unit, at least one out of a personal computer (PC), an input device, and a monitor as a display may also be connected via the interface.

[0035]

20 Further, the calculation processing unit 31 includes an image processing unit 32. The image processing unit 32 includes a positional misalignment detection unit 33 and a dimension measurement unit 34. The dimension measurement unit 34 performs image processing on the basis of the information of the image captured by the camera main body 24, and measures the dimensions of the to-be-measured object 90 stored in the
25 measurement storage chamber 51 (FIG. 2).

[0036]

Before performing measurement of the dimensions described above, the positional misalignment detection unit 33 detects presence or absence of positional misalignment of

the to-be-measured object 90 from the predetermined specific position, on the basis of the information of the image captured by the camera main body 24.

[0037]

Further, the measurement device 20 includes a notification unit 37 and a reimaging button 38. The notification unit 37 is a display unit formed with a liquid crystal display (LCD) disposed on the front side of the home delivery box 12, for example. The notification unit 37 issues notification of inquiry to the user as to whether or not to reposition the to-be-measured object 90 when the positional misalignment of the to-be-measured object 90 is detected by the image processing unit 32. For example, "Home delivery article is misaligned from proper position. Need to reposition?" or the like is displayed on the notification unit 37.

[0038]

The reimaging button 38 corresponds to a reimaging instruction unit, and a signal indicating that the reimaging button 38 is operated is transmitted to the control device 30. When operated by the user, the reimaging button 38 gives, via the control device 30, an instruction to the imaging unit 23 to re-capture the image of the to-be-measured object 90. The reimaging button 38 also includes a repositioning notification function for notifying the control device 30 that the user has decided to reposition the to-be-measured object 90. Specifically, when the reimaging button 38 is operated, the control device 30 gives an instruction to the imaging unit 23 to re-capture the image inside the measurement storage chamber 51. The image processing unit 32 redetects presence or absence of positional misalignment of the to-be-measured object 90 from the specific position on the basis of the information of the image re-captured by the imaging unit 23. As a result, the user can reposition the to-be-measured object 90 until there is no such notification of inquiry described above, so that the measurement device 20 can measure the dimensions of the to-be-measured object 90 placed accurately at the prescribed position with high precision. Note that the notification unit may be the display of the above-described operation display unit 17 (FIG. 1). Further, the notification unit may not be a display unit but may be a

voice output unit so as to notify inquiry to the user as to whether or not to reposition the to-be-measured object 90 using voice.

[0039]

Referring to FIG. 4, detection of positional misalignment and the method for measuring the dimensions according to the embodiment will be described. FIG. 4 is a flowchart showing detection of positional misalignment and measurement of the dimensions according to the embodiment. In step S11, the control device 30 determines whether or not the to-be-measured object 90 inside the measurement storage chamber 51 is detected. When the to-be-measured object 90 is placed in the measurement storage chamber 51 and the door 52 is closed, it is detected by the package sensor 19 that there is a package. Therefore, the result determined in step S11 is positive, and the processing is shifted to step S12. In a case where the result determined in step S11 is negative, the processing of step S11 is repeated. Note that a weight display unit may be disposed at the upper end part, for example, within the measurement storage chamber 51 to display the weight when the package sensor 19 detects the weight of the to-be-measured object.

[0040]

After the illumination device 25 is turned on in step S12, the camera main body 24 captures an image inside the measurement storage chamber 51 in step S13.

[0041]

Then, in step S14, the image processing unit 32 acquires an image for measurement, a binary image 40 (FIG. 5(a)), and a corrected image 41 (FIG. 5(b)). Specifically, the image processing unit 32 executes a correction mode based on the image captured by the camera main body 24. The correction mode calculates distortion correction data for correcting edges, that are each of sides of the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a of the measurement storage chamber, to a straight-line form in the original image stored in advance in the memory unit 35 (FIG. 3). The correction mode corrects, using the distortion correction data, the image for

measurement that is a captured image of a state where the to-be-measured object is placed in the measurement storage chamber.

[0042]

More specifically, the correction mode performs noise removal and filtering
5 processing based on luminance values on the original image stored in the memory unit 35. Then, binarization is performed on the filter-processed image to detect edges and acquire a binary image that is the image including the edges. Then, from the information regarding the shapes and luminance values of each of the markers stored in advance in the memory unit 35, the correction mode identifies the markers 61, 62, and 63 of the binary image by
10 performing pattern matching. Then, from each of the identified markers 61, 62, and 63, edges A1 to A9 of the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a within the binary image are identified.

[0043]

The correction mode then performs adjustment by calculating the intrinsic
15 parameters that associate the coordinates of the binary image before the distortion is corrected and the binary image after the distortion is corrected. The intrinsic parameters are configured with the optical-axis center coordinate, focal distance, lens distortion coefficient, and the like. In a captured image of a checkerboard, for example, positions of intersection points of the patterns thereof are detected, and the intrinsic parameter is
20 calculated such that the intervals between the intersection points become equivalent. At this time, the intrinsic parameter becomes the correction data.

[0044]

The correction mode then corrects distortion of the edges A1 to A9 of the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a by using
25 the intrinsic parameter to make the edges A1 to A9 into a straight-line form so as to acquire the corrected binary image. Note that the correction mode may acquire a binary image in which distortion of the edges A1 to A9 is corrected by using something other than the intrinsic parameter.

[0045]

Then, in a state where the to-be-measured object 90 is disposed at the specific position in the measurement storage chamber 51, the correction mode captures, using the imaging unit 23, an image of the lower-surface part 53a, the first side-surface part 55a, the second side-surface part 56a, the markers 61, 62, 63, and the to-be-measured object 90 to acquire the image for measurement. Then, the correction mode performs noise removal, filtering processing, and binarization on the image for measurement to acquire the binary image 40 as shown in FIG. 5(a). In the binary image 40, the edges A1 to A9 of the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a and edges T1 to T8 of the to-be-measured object are identified.

[0046]

The correction mode then corrects the distortion of the edges A1 to A9 of the first side-surface part 55a, the second side-surface part 56a, and the lower-surface part 53a and the edges T1 to T9 of the to-be-measured object by using the binary image and the acquired correction data described above to acquire the corrected image 41 that is the corrected binary image as shown in FIG. 5(b). As for the measurement of the dimensions of the to-be-measured object 90 to be described later, it is possible to measure the dimensions of the to-be-measured object 90 by calculating the lengths of the edges of the to-be-measured object 90 in the directions indicated by arrows C1, C2, and C3 in FIG. 5(b).

[0047]

Then, in step S15 of FIG. 4, the image processing unit 32 detects presence or absence of positional misalignment of the to-be-measured object 90 from the specific position.

[0048]

FIG. 6 is a diagram showing four kinds of scanning line directions for measuring the dimensions in the corrected image when the to-be-measured object 90 is disposed at the specific position of the measurement storage chamber 51. FIG. 7(a) is a chart showing a

first height graph that shows changes in the length of first scanning lines E1 shown in FIG. 6, and FIG. 7(b) is a chart showing a second height graph that shows changes in the length of second scanning lines E2 shown in FIG. 6. FIG. 7(c) is a chart showing a width graph that shows changes in the length of third scanning lines E3 shown in FIG. 6, and FIG. 7(d) is a chart showing a depth graph that shows changes in the length of fourth scanning lines E4 shown in FIG. 6.

[0049]

In the corrected image shown in FIG. 6, the to-be-measured object 90 is accurately disposed at the specific position. By the use of such a corrected image, the dimensions of the to-be-measured object 90 can be measured with high precision. At this time, the image processing unit 32 uses the scanning lines for scanning pixels, which are the scanning lines in the image processing direction in the image. For example, the image processing unit 32 can use a plurality of scanning lines E1 for scanning the pixels arranged along the length direction of the edge A1 of the first side-surface part 55a. Further, while a checkerboard pattern is shown in the lower-surface part 53a in FIG. 6, display of such a pattern may be omitted.

[0050]

In FIG. 6, the first scanning lines E1 are shown with solid arrows. The first scanning lines E1 are scanned from the edge A2 toward the edge A4 until reaching one of the plurality of edges A1 to A9 and T1 to T8. Then, the image processing unit 32 calculates the length of the plurality of first scanning lines E1 to acquire the first height graph shown in FIG. 7(a). In the first height graph, the reference coordinate G corresponds to the reference corner part 58 (FIG. 2) and, when the scanning line goes away from the reference coordinate G along the edge A4, the length of the scanning line is maintained at a short first length L1 on the side close to the reference coordinate G. At this time, the length of the first scanning lines E1 is defined by the upper end of the to-be-measured object 90. In the meantime, the first scanning lines E1 are out of the to-be-measured object 90 at the position away from the reference coordinate G by a specific

length, so that the length of the scanning lines becomes a second length L2 increased in a step-like form, and the length of the scanning lines is maintained at the second length L2 even at positions further away from the reference coordinate G. Therefore, it is possible to calculate height H1 of the to-be-measured object 90 by calculating the difference
5 between the second length L2 and the first length L1 in the first height graph. The height H1 is the dimension of the to-be-measured object 90 in the direction of the arrow C1 in FIG. 5(b).

[0051]

The image processing unit 32 can also use a plurality of second scanning lines E2
10 for scanning the pixels arranged along the length direction of the edge A1 of the second side-surface part 56a. In FIG. 6, the second scanning lines E2 are shown with arrows of dashed and dotted lines. The second scanning lines E2 are scanned from the edge A6 toward the edge A7 until reaching one of the plurality of edges A1 to A9 and T1 to T8. Then, the image processing unit 32 calculates the length of the plurality of second scanning
15 lines E2 to acquire the second height graph shown in FIG. 7(b). In the second height graph, when the scanning line goes away from the reference coordinate G along the edge A7, the length of the scanning lines is maintained at the short first length L1 on the side close to the reference coordinate G. At this time, the length of the second scanning lines E2 is defined by the upper end of the to-be-measured object 90. In the meantime, the
20 second scanning lines E2 are out of the to-be-measured object 90 at the position away from the reference coordinate G by a specific length, so that the length of the scanning lines becomes the second length L2 increased in a step-like form, and the length of the scanning lines is maintained at the second length L2 even at positions further away from the reference coordinate G. Therefore, it is also possible to calculate the height H1 of the to-
25 be-measured object 90 by calculating the difference between the second length L2 and the first length L1 in the second height graph.

[0052]

The image processing unit 32 can also use a plurality of third scanning lines E3 for scanning the pixels arranged along the length direction of the edge A4 of the lower-surface part 53a. In FIG. 6, the third scanning lines E3 are shown with arrows of dashed and double-dotted lines. The third scanning lines E3 are scanned from the edge A9 toward the edge A7 until reaching one of the plurality of edges A1 to A9 and T1 to T8. Then, the image processing unit 32 calculates the length of the plurality of third scanning lines E3 to acquire the width graph shown in FIG. 7(c). In the width graph, when the scanning line goes away from the reference coordinate G along the edge A7, the length of the scanning lines is maintained at a short third length L3 on the side close to the reference coordinate G. At this time, the length of the third scanning lines E3 is defined by the edge T5 at the front end of the to-be-measured object 90. In the meantime, the third scanning lines E3 are out of the to-be-measured object 90 at the position away from the reference coordinate G by a specific length, so that the length of the scanning lines becomes a fourth length L4 increased in a step-like form, and the length of the scanning lines is maintained at the fourth length L4 even at positions further away from the reference coordinate G. Therefore, it is possible to calculate front-and-back-direction dimension H2 of the to-be-measured object 90 by calculating the difference between the fourth length L4 and the third length L3 in the width graph. The front-and-back-direction dimension H2 is the dimension of the to-be-measured object 90 in the direction of the arrow C2 in FIG. 5(b).

[0053]

The image processing unit 32 can also use a plurality of fourth scanning lines E4 for scanning the pixels arranged along the length direction of the edge A7 of the lower-surface part 53a. In FIG. 6, the fourth scanning lines E4 are shown with arrows of long dashed lines. The fourth scanning lines E4 are scanned from the edge A8 toward the edge A4 until reaching one of the plurality of edges A1 to A9 and T1 to T8. Then, the image processing unit 32 calculates the length of the plurality of fourth scanning lines E4 to acquire the depth graph shown in FIG. 7(d). In the depth graph, when the scanning line goes away from the reference coordinate G along the edge A4, the length of the scanning

lines is maintained at a short fifth length L5 on the side close to the reference coordinate G. At this time, the length of the fourth scanning lines E4 is defined by the edge T4 at the right end of the to-be-measured object 90. In the meantime, the fourth scanning lines E4 are out of the to-be-measured object 90 at the position away from the reference coordinate G by a specific length, so that the length of the scanning lines becomes a sixth length L6 increased in a step-like form, and the length of the scanning lines is maintained at the sixth length L6 even at positions further away from the reference coordinate G. Therefore, it is possible to calculate left-and-right-direction dimension H3 of the to-be-measured object 90 by calculating the difference between the sixth length L6 and the fifth length L5 in the depth graph. The left-and-right-direction dimension H3 is the dimension of the to-be-measured object 90 in the direction of the arrow C3 in FIG. 5(b). While the second to fourth scanning lines E2, E3, and E4 are shown with dashed and dotted lines, dashed and double-dotted lines, and long dashed lines, respectively, in FIG. 6 and FIG. 7, each of the scanning lines can actually be shown with a solid line. Further, the first to fourth scanning lines E1 to E4 may be shown with different colors so as to be identifiable.

[0054]

As described above, when the to-be-measured object 90 is accurately placed at the specific position of the measurement storage chamber 51, the dimensions of the to-be-measured object 90 can be measured with high precision. In the meantime, there may be a case where the user may actually place the to-be-measured object 90 at a position misaligned from the specific position within the measurement storage chamber 51. In such cases, it is not possible to measure the dimensions of the to-be-measured object 90 with high precision. In the embodiment, in such a case, the positional misalignment detection unit 33 of the image processing unit 32 detects presence or absence of positional misalignment of the to-be-measured object 90 by using the above-described correction drawing.

[0055]

FIG. 8 is a diagram showing a first example of detection of positional misalignment when the to-be-measured object 90 is disposed at a position misaligned from the specific position in the measurement storage chamber 51, and is a diagram corresponding to FIG. 6.

FIG. 9 is a chart showing a depth graph that shows changes in the length of the fourth

5 scanning lines E4 shown in FIG. 8. As shown in FIG. 8, there may be a case where the to-be-measured object 90 is disposed away from the second side-surface part 56a including the edges A1 and A7. In such case, the image processing unit 32 acquires the depth graph based on the fourth scanning lines E4 as shown in FIG. 9. As is clear from the

10 comparison of FIG. 7(a) and FIG. 9, in the depth graph of FIG. 9, the fourth scanning lines E4 do not reach the edge T4 of the to-be-measured object 90 at the part close to the reference coordinate G, and the length of the scanning lines increases radically. The positional misalignment detection unit 33 measures the change in the length of the scanning lines in the depth graph to detect the positional misalignment of the to-be-measured object 90. For example, when there is measured, from the data corresponding

15 to the graph that shows the change in the length of the scanning lines, a change of increase in the length of the scanning lines that becomes closer to the reference coordinate G in the vicinity of the reference coordinate G, it is detected that there is positional misalignment.

[0056]

FIG. 10 is a diagram showing a second example of detection of positional

20 misalignment when the to-be-measured object 90 is disposed at a position misaligned from the specific position in the measurement storage chamber 51, and is a diagram corresponding to FIG. 6.

FIG. 11(a) is a chart showing a first height graph that shows changes in the length of the first scanning lines E1 shown in FIG. 10, and FIG. 11(b) is a chart showing a second height graph that shows changes in the length of the second

25 scanning lines E2 shown in FIG. 10.

[0057]

As in the example shown in FIG. 8, the to-be-measured object 90 is also disposed away from the second side-surface part 56a in the example shown in FIG. 10. In this

case, the image processing unit 32 uses the first scanning lines E1 and the second scanning lines E2 to acquire the first height graph and the second height graph shown in FIGS. 11(a) and (b). As is clear from the comparison of FIG. 7(a) and FIG. 11(a), in the first height graph of FIG. 11(a), the first scanning lines E1 do not reach the edge T8 of the to-be-measured object 90 at the part close to the reference coordinate G, and the length of the scanning lines increases radically. The positional misalignment detection unit 33 measures the change in the length of the scanning lines in the first height graph to detect the positional misalignment of the to-be-measured object 90. For example, when there is measured, from the data corresponding to the graph that shows the change in the length of the scanning lines, a change of increase in the length of the scanning lines that becomes closer to the reference coordinate G in the vicinity of the reference coordinate G, it is detected that there is positional misalignment.

[0058]

Further, as is clear from the comparison of FIGS. 11(a) and (b), a shortest length L1a of the second scanning lines E2 set when reaching the edge T2 of the to-be-measured object 90 in the second height graph is longer than the shortest length L1 of the first scanning lines E1 set when reaching the edge T8 of the to-be-measured object 90 in the first height graph. This is because the to-be-measured object 90 is away from the second side-surface part 56a. Therefore, the positional misalignment detection unit 33 may measure the change in the length of the scanning lines in the first height graph and the second height graph. At this time, the positional misalignment detection unit 33 may detect that there is positional misalignment when an absolute value of a difference Ha between the shortest length L1 of the first scanning lines E1 in the first height graph and the shortest length L1a of the second scanning lines E2 in the second height graph is equal to or larger than a specific value set in advance.

[0059]

Further, as shown in FIG. 8 and FIG. 10, when the to-be-measured object 90 is disposed away from the second side-surface part 56a, the length of the scanning lines

becomes short at the part close to the reference coordinate G in the width graph (see FIG. 7(c)) based on the third scanning lines E3 shown in FIG. 6. In the meantime, it is not possible to detect whether the length of the scanning lines is good or bad only from the width graph. Therefore, it is difficult to detect positional misalignment of the to-be-measured object 90 only with the width graph, in a case where the to-be-measured object 90 is disposed away from the second side-surface part 56a.

[0060]

In the meantime, while described above is the case where the to-be-measured object 90 is disposed away from the second side-surface part 56a, there may also be a case where the to-be-measured object 90 is disposed away from the first side-surface part 55a. In this case, positional misalignment of the to-be-measured object 90 can be detected by using the width graph based on the third scanning lines E3, or one or both of the first and second height graphs based on the first scanning lines E1 and the second scanning lines E2.

[0061]

As described, while the positional misalignment detection unit 33 may be able to detect presence or absence of positional misalignment of the to-be-measured object 90 by using only part of the first to fourth scanning lines E1 to E4, it is more preferable to detect positional misalignment by using all of the first to fourth scanning lines E1 to E4 in order to increase detection accuracy.

[0062]

Then, in step S16 of FIG. 4, the control device 30 determines whether or not there is positional misalignment of the to-be-measured object 90. When it is determined that there is positional misalignment as described above, the processing is shifted to step S17 where the control device 30 issues notification, using the notification unit 37 (FIG. 3), that there is positional misalignment to make an inquiry as to whether or not to reposition the to-be-measured object 90.

[0063]

Then, in step S18 of FIG. 4, the control device 30 determines whether or not there is an instruction to re-capture an image via the reimaging button 38 (FIG. 3). When it is determined that there is an instruction to re-capture an image via the reimaging button 38, the processing returns to step S11 to repeat the processing therefrom. Thereby, the image processing unit 32 redetects presence or absence of positional misalignment of the to-be-measured object 90 from the specific position on the basis of the information of the image re-captured by the imaging unit 23.

[0064]

In the meantime, when it is determined in step S18 that there is no instruction to re-capture an image via the reimaging button 38, and when it is determined in step S16 that there is no positional misalignment of the to-be-measured object 90, the processing is shifted to step S19.

[0065]

In step S19, the dimensions of the to-be-measured object 90 are measured from the corrected image in the manner described above by the dimension measurement unit 34 (FIG. 3) of the image processing unit 32.

[0066]

Thereafter, in step S20, the control device 30 displays the measurement results of the dimensions of the to-be-measured object 90 on the operation display unit 17 (FIG. 1). The control device 30 may calculate the shipping fee of the to-be-measured object 90 by using the measurement results of the dimensions. Alternatively, the volume of the to-be-measured object 90 may be calculated by using the measurement results of the dimensions.

[0067]

With the dimension measurement device 20 of the home delivery box described above, when the to-be-measured object 90 is misaligned from the specific position in a state where the to-be-measured object 90 is placed in the measurement storage chamber 51, the notification unit 37 issues notification of inquiry as to whether or not to reposition the to-be-measured object 90. In response to that instruction, the user can reposition the to-

be-measured object 90 until there is no such notification, so that the dimension measurement device 20 can measure the dimensions of the to-be-measured object 90 placed accurately at the specific position with high precision.

[0068]

5 FIG. 12 is a drawing showing a method for detecting positional misalignment when the to-be-measured object 90 is disposed obliquely with respect to the first side-surface part 55a and the second side-surface part 56a at a position misaligned from the specific position in the measurement storage chamber 51, and is a diagram corresponding to FIG. 6. FIG. 13 is a chart showing a depth graph that shows changes in the length of the fourth scanning lines E4 shown in FIG. 12.

[0069]

As shown in FIG. 12, when the to-be-measured object 90 is disposed obliquely with respect to the first side-surface part 55a and the second side-surface part 56a, the image processing unit 32 acquires the depth graph as shown in FIG. 13 by using the fourth scanning lines E4. As is clear from the comparison of FIG. 7(d) and FIG. 13, in the depth graph of FIG. 13, the fourth scanning lines E4 do not reach the edge T4 of the to-be-measured object 90 at the part close to the reference coordinate G, and the length of the scanning lines increase radically. Further, the lengths of the scanning lines to the edge T4 of the to-be-measured object 90 at positions away from the reference coordinate G become longer as going away from the reference coordinate G. The positional misalignment detection unit 33 can detect not only the positional misalignment of the to-be-measured object 90 but also oblique positioning thereof, by measuring the change in the length of the scanning lines in the depth graph. For example, when there is measured, from the data corresponding to the graph that shows the change in the length of the scanning line shown in FIG. 13, a change of increase in the length of the scanning lines becoming closer to the reference coordinate G in the vicinity of the reference coordinate G, it is detected that there is positional misalignment. Along with that, when there is measured, from the data corresponding to the graph that shows the change in the length of the scanning lines shown

in FIG. 13, a change of gradual increase in the length of the scanning line as going away from the reference coordinate G in a range away from the reference coordinate G, it is detected that there is oblique positioning of the to-be-measured object 90.

[0070]

5 While the case where the to-be-measured object 90 is in a cuboid shape is described above, the external shape of the to-be-measured object is not limited thereto but may be in other shapes such as a columnar shape and the like.

[0071]

Further, the reimaging instruction unit that issues an instruction to re-capture the
10 image of the to-be-measured object is not limited to the reimaging button 38 but may also be an operation display unit or the like on the touch panel of the operation display unit 17.

[0072]

FIG. 14 is a perspective view of a home delivery box 12a according to another example of the embodiment. In the home delivery box 12a, a plurality of home-delivery
15 storage chambers 14a and 14b are disposed in line on the top and bottom on the left side L of an exterior body 13a. On the right side R of the exterior body 13a, an operation panel unit 16 including an operation display unit 17a and a dimension measurement device 20a are disposed in line on the top and bottom. A barcode reader 72, an IC-card reader 73, a printer 74, and a security camera 75 are installed on the operation panel unit 16.

20 [0073]

For example, a menu screen is displayed on the operation display unit 17a, and when the user touches and makes selection from a plurality of items displayed on the menu screen, the control device 30 (see FIG. 3) executes processing according to the selection. For example, on the menu screen, "measure" to be a trigger for starting measurement of
25 dimensions is displayed.

[0074]

The doors of the home-delivery storage chambers 14a and 14b may be configured to be locked with an electric lock and unlocked by using a barcode, an IC card, or the like.

The printer 74 may print payment information when the sender of the home delivery article operates the operation display unit 17a or the like to settle the payment of the shipping fee. The security camera 75 is used for monitoring presence or absence of a suspicious person near the home delivery box 12a.

5 [0075]

FIG. 15 is a perspective view showing a measurement storage chamber 51a of the dimension measurement device 20a according to another example of the embodiment. The measurement storage chamber 51a is closed by a door 52a. On the upper side of the measurement storage chamber 51a with the door 52a being opened, a panel unit 76 is
10 exposed, and a weight display unit 77 formed with a liquid crystal display unit is disposed on the panel unit 76. On the bottom part of the measurement storage chamber 51a, a weight measurement unit 78 is disposed. The weight measurement unit 78 includes, on a top surface, for example, a movable part that is capable of moving in the up-and-down direction, and the movable part includes an elastic member (not shown) between the top
15 surface and a fixed part on the lower side. As the weight of a package 91 that corresponds to the to-be-measured object becomes heavier, the movable part moves to the lower side by opposing the elasticity of the elastic member. As a result, the weight of the package 91 is measured from the position of the movable part in the up-and-down direction. The measured weight is displayed on the weight display unit 77. The top
20 surface of the movable part corresponds to the bottom surface of the measurement storage chamber 51a. The weight measurement unit 78 functions as a package sensor that detects presence of the package 91 in the measurement storage chamber 51a, when the measured weight is equal to or more than a specific value.

[0076]

25 The imaging unit 23 is installed on the left side L of the opening end part on the upper side of the measurement storage chamber 51a. The camera main body of the imaging unit 23 is disposed facing obliquely downward so as to capture the package 91 placed at the right corner part on the far side on the lower part of the measurement storage

chamber 51a. The control device 30 (FIG. 3) connected to the imaging unit 23 includes the image processing unit 32 (FIG. 3). The imaging unit 23 also includes the illumination device 25 (see FIG. 3). A lower-surface part 53b of the measurement storage chamber 51a is formed with a metal plate such as iron or steel, for example. The lower-surface part 53b has a silver color, for example. The lower-surface part 53b may also be another color without a pattern.

[0077]

The image processing unit 32 measures dimensions of the package 91 from the image including edges of the package 91 acquired by the imaging unit 23. Therefore, in the image processing unit 32, an image for measurement including the edges showing boundary lines of the package 91 is generated. At this time, as will be described later, the image processing unit 32 sets a threshold value for distinguishing a line of a reflected image of the package 91 appearing on the lower-surface part 53b that is the bottom surface of the measurement storage chamber 51a generated by reflection of light from the boundary line between the lower-surface part 53b of the measurement storage chamber 51a and the actual package 91. Then, the image processing unit 32 recognizes that the edges show the boundary lines of the package 91, when the difference in the brightness of the edges of the image captured by the imaging unit 23 and the part adjacent to the edges exceeds the threshold value. Then, the image processing unit 32 measures the dimensions of the package 91 based on the edges showing the boundary lines. As a result, the dimensions of the package 91 can be measured with still higher precision.

[0078]

FIG. 16 is a flowchart showing the procedure for generating an image for measurement for measuring dimensions according to another example of the embodiment. The image for measurement is generated using the dimension measurement device 20a shown in FIG. 14 and FIG. 15. Hereinafter, reference signs in FIG. 3, FIG. 14, and FIG. 15 are used for description. In step S30, the user selects "measure" on the menu screen of

the operation display unit 17a with the door 52a being closed without placing the package 91 in the measurement storage chamber 51a.

[0079]

As a result, in step S31, the control device 30 controls the imaging unit 23 to
5 capture an image of the measurement storage chamber 51a by taking the operation of selection as a trigger to acquire an image A that is the image without the package shown in FIG. 17 from the captured image,.

[0080]

Then, in step S32 of FIG. 16, the user places the package 91 in the vicinity of the
10 reference corner part 58 (FIG. 17) on the lower-surface part 53b of the measurement storage chamber 51a so as to be almost in contact with the first side-surface part 55a and the second side-surface part 56a, that is, along the far-side corner. As a result, the weight measurement unit 78 detects presence of the package 91, and the detection signal thereof is transmitted to the control device 30.

15 [0081]

Then, in step S33, when the door 52a is closed in a state where it is detected that the package 91 is placed inside, the control device 30 controls the imaging unit 23 to capture the image of the measurement storage chamber 51a and the package 91. Then, the control device 30 acquires an image B that is the image with the package shown in FIG. 18
20 from the captured image,. FIG. 18 shows a case where the package 91 in a cuboid shape is disposed in the measurement storage chamber 51a.

[0082]

Thereafter, in step S34 of FIG. 16, the control device 30 generates an image C including only the package 91, of the measurement storage chamber 51a and the package
25 91 as shown in FIG. 19, from a difference between the image A and the image B. In the image C, displayed are three rectangular frames 81, 82, and 83 formed to go along the surfaces of the first side-surface part, the second side-surface part, and the lower-surface part, respectively. For example, the three rectangular frames 81, 82, and 83 are drawn

with solid lines of colors that are different from each other, such as red, blue, and green. The rectangular frames 81, 82, and 83 are used for determining positions of the edges of the external shape of the package 91 by the image processing unit 32 of the control device 30.

5 [0083]

Then, in step S35 of FIG. 16, changed parts within the image are found to detect the edges in each of the images within the surfaces of the rectangular frames 81, 82, and 83 corresponding to the first side-surface part, the second side-surface part, and the lower-surface part. FIG. 20 is a drawing showing the method for detecting edges from each of the images of three surfaces inside the measurement storage chamber in the image C of FIG. 19.

[0084]

Within each of the surfaces of the two rectangular frames 81 and 82 corresponding to the first side-surface part 55a (FIG. 17) and the second side-surface part 56a (FIG. 17), the image processing unit 32 scans the pixels along the length direction of the edge A1 from the edges A2 and A6 on the far side of the package 91 toward the edges A4 and A7 near the package 91 by using the plurality of first scanning lines E1 and the plurality of second scanning lines E2. Then, the image processing unit 32 finds changed parts such as changes in the luminance or the like within the images of each of the surfaces of the two rectangular frames 81 and 82, and detects the positions thereof as edges T8a and T2a of the package.

[0085]

Further, within the surface of the rectangular frame 83 corresponding to the lower-surface part 53b (FIG. 17), the image processing unit 32 scans the pixels along the length direction of the edges A4 and A7 from the edges A9 and A8 on the far side of the package 91 toward the edges A7 and A4 near the package 91 by using the plurality of third scanning lines E3 and the plurality of fourth scanning lines E4. Then, the image processing unit 32 finds changed parts such as changes in the luminance or the like within

the images of the surface of the rectangular frame 83, and detects the positions thereof as edges T5a and T4a of the package.

[0086]

Along with that, the image processing unit 32 recognizes edges showing boundary
5 lines between the package 91 and the surfaces of the measurement storage chamber 51a based on the luminance differences between the edges T2a, T4a, T5a, and T8a detected regarding the package 91 and the parts adjacent to the edges T2a, T4a, T5a, and T8a.

[0087]

FIG. 21 is a diagram in which the edges T2a, T4a, T5a, and T8a detected regarding
10 the package 91 in FIG. 20 are emphasized. FIG. 22 is a diagram showing an enlarged view of the image in the vicinity of the package 91 in FIG. 21. When recognizing the edges of the package 91 described above, the image processing unit 32 sets a threshold value for distinguishing a line 93 of a reflected image 92 of the package 91 appearing on the lower-surface part of the measurement storage chamber generated by reflection of light
15 from the boundary line between the lower-surface part of the measurement storage chamber 51a and the actual package 91. Then, the image processing unit 32 recognizes that the edges show the boundary lines of the package 91, when the difference in the brightness of the edges of the image captured by the imaging unit 23 and the parts adjacent to the edges exceeds the threshold value.

20 [0088]

In step S36 of FIG. 16, the edges of the cuboid package 91 are decided from the detected edges, and generation of the image for measurement is thereby completed. The image processing unit 32 measures dimensions of the package 91 based on the edges of the image for measurement. After step S36, the image processing unit 32 acquires a
25 corrected image in which distortion of the edges is corrected as in step S14 of FIG. 4 and, thereafter, performs the same processing as that of steps S15 to S20 of FIG. 4.

[0089]

When measuring the dimensions of the package 91 in the same manner as in step S19 of FIG. 4, the dimensions of the package 91 may also be measured from a proportional relationship between the external shape of the package 91 calculated from the detected edges and the actual dimensions between each of the edges of the three rectangular frames 81, 82, and 83 generated in advance.

[0090]

FIG. 22 schematically shows the differences in the brightness with a diagonal lattice part D1, a diagonal line part D2, a sand-pattern part D3, and a plain part D4 on the inner side of the diagonal lattice part D1. As for the brightness, the diagonal lattice part D1 is the darkest, and it becomes brighter in order from the diagonal line part D2, the sand-pattern part D3, to the plain part D4, that is the brightest. A plain part D5 on the outer side of the diagonal lattice part D1 is also the darkest, like the diagonal lattice part D1. For simplifying the drawing, the plain part D5 is not illustrated as the diagonal lattice part. Further, the difference in the brightness between the plain part D4 on the inner side of the diagonal lattice part D1 and the sand-pattern part D3 is larger than the difference in the brightness between the sand-pattern part D3 and the diagonal lattice part D1. In FIG. 22, the line 93 of the reflected image 92 of the package 91 appears due to the reflection of light within the surface of the rectangular frame 83 corresponding to the lower-surface part.

[0091]

As for the differences in the brightness between the edges in the image captured by the imaging unit 23 and the parts adjacent to the edges, the difference in the brightness of both sides sandwiching the line 93 of the reflected image 92 does not exceed the threshold value, whereas the difference in the brightness of both sides sandwiching the edge T4a at the lower right end of the package 91 exceeds the threshold value. As a result, the image processing unit 32 recognizes that the edge T4a shows the accrual boundary line of the package 91.

[0092]

In the meantime, when the image processing unit 32 does not recognize things above, the line 93 of the reflected image 92 may be misrecognized as the edge showing the boundary of the package 91. In such a case, the image for measurement generated by using the line 93 does not show the external shape of the actual package, with the result that the measurement accuracy is deteriorated when the dimensions of the package are measured by using such an image for measurement. According to the configuration of the example whose procedure is shown in FIG. 16, it is possible to prevent such inconvenience and to improve the accuracy for measuring the dimensions of the package 91.

10 [0093]

In FIG. 22, both sides of the edge T8a at the upper left end of the package 91 are the darkest parts and the difference in the brightness is small, so that it may be hard to recognize the edge T8a as the edge showing the boundary of the package 91. In the meantime, the difference in the brightness of both sides of the edge T2a at the upper right end of the package 91 is great, so that the edge T2a can be detected with high precision. Therefore, the edge T8a can be easily acquired by calculation from the point of intersection between the edge T2a and the edge A1 of the measurement storage chamber, a parallel relation with respect to the edge A4 of the measurement storage chamber, and the like. In the example, other configurations and effects are the same as those shown in FIG. 1 to FIG. 13.

REFERENCE SIGNS LIST

[0094]

- 12, 12a Home delivery box
- 25 13, 13a Exterior body
- 14, 14a, 14b Home-delivery storage chamber
- 15 Door
- 16 Operation panel unit

	17, 17a	Operation display unit
	18	Electric lock
	19	Package sensor
	20, 20a	Dimension measurement device (measurement device)
5	23	Imaging unit
	24	Camera main body
	25	Illumination device
	30	Control device
	31	Calculation processing unit
10	32	Image processing unit
	33	Positional misalignment detection unit
	34	Dimension measurement unit
	35	Memory unit
	36	Interface
15	37	Notification unit
	40	Binary image
	41	Corrected image
	51, 51a	Measurement storage chamber
	52, 52a	Door
20	53	Base plate part
	53a, 53b	Lower-surface part
	54	Right-wall part
	55	Left-wall part
	55a	First side-surface part
25	56	Back-wall part
	56a	Second side-surface part
	57	Top plate part
	58	Reference corner part

- 61 First marker
- 62 Second marker
- 63 Third marker
- 70 Payment unit
- 5 81, 82, 83 Rectangular frame
- 90 To-be-measured object
- 91 Package
- 92 Reflected image
- 93 Line

10

CLAIMS

[Claim 1]

A dimension measurement device for a home delivery box, the dimension

5 measurement device comprising:

a storage chamber in which a to-be-measured object is stored in such a manner as to be capable of being taken in and out of the storage chamber;

an imaging unit which captures an image of the to-be-measured object to be stored in the storage chamber;

10 an image processing unit which measures dimensions of the to-be-measured object by performing image processing thereon on the basis of information of the image captured by the imaging unit and which detects, on the basis of the image information, presence or absence of positional misalignment from a predetermined specific position for the to-be-measured object; and

15 a notification unit which, in a case when the positional misalignment has been detected by the image processing unit, issues notification of inquiry as to whether or not the to-be-measured object is to be repositioned.

[Claim 2]

The dimension measurement device for a home delivery box according to claim 1,

20 wherein the image processing unit detects the positional misalignment by measuring a change in length of scanning lines in an image processing direction in the image.

[Claim 3]

The dimension measurement device for a home delivery box according to claim 1 or claim 2, comprising a reimaging instruction unit which issues an instruction to re-

25 capture an image of the to-be-measured object when operated, wherein

when the reimaging instruction unit is operated, the image processing unit redetects presence or absence of positional misalignment of the to-be-measured object from the specific position on the basis of information of the image re-captured by the imaging unit.

[Claim 4]

The dimension measurement device for a home delivery box according to any one of claims 1 to 3, comprising an illumination device which illuminates inside the storage chamber, the illumination device being disposed as part of the imaging unit or as a device
5 different from the imaging unit.

[Claim 5]

The dimension measurement device for a home delivery box according to any one of claims 1 to 4, wherein

the image processing unit: sets a threshold value for distinguishing a line of a
10 reflected image of the to-be-measured object appearing on a bottom surface of the storage chamber generated by reflection of light from a boundary line between the bottom surface of the storage chamber and the actual to-be-measured object; when a difference in brightness between an edge of the image captured by the imaging unit and a part adjacent to the edge exceeds the threshold value, recognizes that the edge shows the boundary line;
15 and measures the dimensions of the to-be-measured object based on the edge.