

[DESCRIPTION]

[TITLE OF INVENTION]

CONTAINER POSITION DETECTION APPARATUS AND CRANE CONTROL
SYSTEM

5

[Technical Field]

[0001]

The present invention relates to a container position detection apparatus and a crane control system.

10

[Background Art]

[0002]

Patent Literature 1 discloses a container position detection apparatus for detecting a position at which a container should be arranged in a container yard.

15 In the container position detection apparatus, an imaging section such as a CCD camera is installed in a spreader of a crane arranged in the container yard and an upper edge or the like of the container is detected by the imaging section in order to find a position at which the container should be arranged (a container arrangement position).

20 [Citation List]

[Patent Literature]

[0003]

[Patent Literature 1]

Japanese Unexamined Patent Application, First Publication No. 2002-205891

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[Summary of Invention]

[Technical Problem]

[0004]

However, a conventional container position detection apparatus evaluates only an amount
5 of deviation in a horizontal direction on an image of the imaging section and cannot
evaluate a physical distance (for instance, how many mm it is displaced). In addition, a
distance to a target container of stacking destination or a target position mark in a height
direction is not known. For this reason, in the above container position detection
apparatus, it is difficult to control a hanging tool or the container gripped by the hanging
10 tool such that the same is accurately loaded at a target position without displacement.
In addition, when the container position detection apparatus is subjected to an influence
of noise or disturbance included in image data acquired by the imaging section because a
quantity of light on an imaging point is insufficient, or when the container position
detection apparatus includes noise or a disturbance itself, it is difficult to accurately find
15 the container arrangement position. For example, there is a problem in that the
container arrangement position is not accurately found when sunlight is reflected by
rainwater that has collected in a container yard or the like after rain.

[0005]

An object of the present invention is to provide a container position detection apparatus
20 capable of accurately and stably finding a container arrangement position, and a crane
control system.

[Solution to Problem]

[0006]

25 In accordance with a first aspect of the present invention, a container position detection

apparatus is a container position detection apparatus detecting a position at which a holding container should be arranged in a container yard, and includes a detection light irradiation unit which radiates detection light from above so as to traverse an upper edge of a stacked container previously arranged in the container yard, a first imaging unit
5 which captures an irradiation range of the detection light obliquely from above, so as to detect first detection light radiated to the holding container and second detection light radiated to an upper surface of the stacked container, and a container position determination unit which finds a container arrangement position based on the first detection light and the second detection light.

10 [0007]

In accordance with a second aspect of the present invention, in the container position detection apparatus according to the first aspect, the container position determination unit may find a height of the upper edge of the stacked container based on a position of the second detection light detected by the first imaging unit.

15 [0008]

In accordance with a third aspect of the present invention, in the container position detection apparatus according to the first aspect, the container position determination unit may find a vertical distance between the holding container and the upper edge of the stacked container based on an amount of deviation between the first detection light and
20 the second detection light.

[0009]

In accordance with a fourth aspect of the present invention, the container position detection apparatus according to any one of the first to third aspects may further include a second imaging unit which captures the container yard so as to detect a mark
25 corresponding to a container arrangement position provided in the container yard, and the

container position determination unit may find the container arrangement position in the container yard based on a position of the mark.

[0010]

In accordance with a fifth aspect of the present invention, in the container position
5 detection apparatus according to the fourth aspect, the first imaging unit may also be used as the second imaging unit.

[0011]

In accordance with a sixth aspect of the present invention, the container position
detection apparatus according to the fourth or fifth aspect may further include an
10 illumination unit which illuminates an imaging range of the second imaging unit.

[0012]

In accordance with a seventh aspect of the present invention, in the container position
detection apparatus according to the sixth aspect, illumination light radiated from the
illumination unit may be set by the same wavelength band as the detection light.

15 [0013]

In accordance with an eighth aspect of the present invention, in the container position
detection apparatus according to the seventh aspect, the wavelength band may be set to
an atmospheric absorption band of sunlight.

[0014]

20 In accordance with a ninth aspect of the present invention, in the container position
detection apparatus according to any one of the first to eighth aspects, the detection light
irradiation unit may radiate the detection light so as to traverse an upper edge of a
preinstalled adjacent container which is previously arranged so as to be adjacent to the
container arrangement position, and the container position determination unit may detect
25 a position of the preinstalled adjacent container.

[0015]

In accordance with a tenth aspect of the present invention, a crane control system includes a crane which moves a container in a container yard, the container position detection apparatus according to any one of the first to ninth aspects, and a control
5 apparatus which controls the crane based on the container arrangement position found by the container position detection apparatus.

[Advantageous Effects of Invention]

[0016]

10 The above-mentioned container position detection apparatus can accurately find a container arrangement position while having resistance to ambient disturbance or noise. The above-mentioned crane control system can accurately arrange a container at a container arrangement position.

15 [Brief Description of Drawings]

[0017]

Fig. 1 is a view showing a crane control system 1 according to an embodiment of the present invention.

Fig. 2 is a view showing a schematic configuration of one container position detection
20 apparatus 20 according to the embodiment of the present invention.

Fig. 3A is a view showing detection light L radiated by a laser projector 25 when viewed from a Y direction.

Fig. 3B is a view showing the detection light L radiated by the laser projector 25 when viewed from an X direction.

25 Fig. 4A is a view showing an image captured by a CCD camera 27 of reflected light of

the detection light L when a vertical distance is long.

Fig. 4B is a view showing an image captured by the CCD camera 27 of reflected light of the detection light L when the vertical distance is short.

Fig. 5A is a view showing illumination light R radiated by an infrared illuminator 26

5 when viewed from the X direction.

Fig. 5B is a view showing the illumination light R radiated by the infrared illuminator 26 when viewed from the Y direction.

Fig. 6A is a view showing an image captured by the CCD camera 27 of reflected light of the illumination light R when the vertical distance is long.

10 Fig. 6B is a view showing an image captured by the CCD camera 27 of reflected light of the illumination light R when the vertical distance is short.

Fig. 7 is a view showing a state in which the detection light L of the laser projector 25 is radiated to containers C3.

15 [Description of Embodiments]

[0018]

Fig. 1 is a view showing a crane control system 1 according to an embodiment of the present invention.

As shown in Fig. 1, the crane control system 1 includes a crane 5, container position

20 detection apparatuses 20, a control apparatus 50, and so on.

The crane 5 is a mechanical apparatus which grips a container C1 serving as a hanging load to move the same toward a container arrangement position A in a container yard G. Each of the container position detection apparatuses 20 is an apparatus for detecting the position at which the container C1 is arranged (a container arrangement position A).

25 The control apparatus 50 is an apparatus which controls the crane 5 based on the

container arrangement position A found by the container position detection apparatus 20.

[0019]

The crane 5 is a tire type bridge crane for a yard which stacks the container C1. The crane 5 includes a crane gantry machine body 10 having a portal shape and a tire type gantry device 11 which allows the crane gantry machine body 10 to travel on a trackless surface in an X direction.

The crane gantry machine body 10 has a pair of upper beams 12 extending in parallel with a horizontal direction (a Y direction). A trolley 13 moving along the upper beams 12 is mounted on the upper beams 12.

10 The trolley 13 includes a hoisting device 14 which moves a spreader 16 through a hanging wire 15 in a vertical direction (a Z direction). The hoisting device 14 moves the spreader 16 hung on the hanging wire 15 in the vertical direction by winding or unwinding the hanging wire 15. The spreader 16 may detachably hold (grip) the container C1.

15 [0020]

The spreader 16 is a planar member which nearly coincides with the shape of an upper surface of the container C1. Two of the container position detection apparatuses 20 are mounted downward to one long side 16a of the spreader 16 extending in the X direction thereof. Another two of the container position detection apparatuses 20 are also mounted downward to one long side 16b which is parallel with the long side 16a. The four container position detection apparatuses 20 all have an identical configuration.

[0021]

The control apparatus 50 is placed on the crane gantry machine body 10. The control apparatus 50 is connected with the four container position detection apparatuses 20 through signal cables (not shown).

[0022]

Here, the above-mentioned arrangement position of the container C1 refers to a rectangular range of an upper surface of a container C2 when the container C2 is previously placed in the container yard G. In addition, in the above-mentioned

5 arrangement position of the container C1, a rectangular range of the same shape as the upper surface of the predetermined container C2 is set when the container is not present. In general, a driver may check the rectangular range with the naked eye by executing marking on the ground. Here, an object of the crane control system 1 to which the present invention is applied is to place the container C1 as a hung container without
10 displacement with respect to the arrangement position of the container C1. To this end, it is necessary to detect the relative positional relationship between the container C1 and the container arrangement position with accuracy and reliability in the crane control system 1.

[0023]

15 Fig. 2 is a view showing a schematic configuration of one container position detection apparatus 20 according to the embodiment of the present invention, when viewed from the Y direction.

[0024]

The container position detection apparatus 20 includes a laser projector 25, an illuminator
20 26, a CCD camera 27, and a transmission filter 28 which coincides with wavelengths of these light sources.

The laser projector (a detection light irradiation unit) 25 radiates detection light L (slit light) having a thin sheet shape in a downward direction from above. The detection light L is a sheet-shaped laser beam spread in the Y direction, and is radiated in the Z
25 direction. The detection light L necessarily has an intensity at which it can be

distinguished from reflected light of sunlight.

The illuminator (illumination unit) 26 is an illuminator using an LED or the like which radiates illumination light R downward from above. The illumination light R is radiated in a beam form (a spot form) in the Z direction.

- 5 The wavelengths of the laser beam (detection light L) and the illumination light R are set to be an atmospheric absorption band of sunlight. Thereby, stable detection can be realized since an influence of the reflected light of the sunlight is reduced.

The laser projector 25 and the illuminator 26 are arranged adjacent to each other.

[0025]

- 10 The CCD camera 27 is mounted to face downward. The CCD camera 27 captures irradiation ranges of the detection light L and the illumination light R. The CCD camera 27 serves both as a camera capturing reflected light of the detection light L and a camera capturing reflected light of the illumination light R.

The CCD camera (first or second imaging unit) 27 is spaced apart from the laser

- 15 projector 25 and inclined with respect to the laser projector 25.

Image data captured by the CCD camera 27 is output to a container position determination unit 55 mounted on the control apparatus 50.

[0026]

Fig. 3A is a view showing the detection light L radiated by the laser projector 25 when

- 20 viewed from the Y direction. Fig. 3B is a view showing the detection light L radiated by the laser projector 25 when viewed from the X direction.

Fig. 4A is a view showing an image (an imaging range) captured by the CCD camera 27 of the reflected light of the detection light L when a vertical distance is long. Fig. 4B is

a view showing an image (an imaging range) captured by the CCD camera 27 of the

- 25 reflected light of the detection light L when the vertical distance is short.

[0027]

As shown in Figs. 3A and 3B, the detection light L from the laser projector 25 is radiated toward the stacking destination container C2 which is previously arranged in the container yard G. The detection light L is radiated so as to traverse a side surface C1S of the container C1 serving as the holding container and an upper edge E of the container (the stacked container) C2 previously arranged in the container yard G. Furthermore, an end portion of the detection light L is radiated to the container yard G. The detection light L is divided into three parts by the containers C1 and C2. In more detail, the detection light L is divided into first detection light L1 and second detection light L2 using a lower end of the container C1 as a boundary. Furthermore, the detection light L is divided into the second detection light L2 and third detection light L3 using the upper edge E of the container C2 as a boundary. The first detection light L1 is reflected light of the detection light L radiated to the container C1. The second detection light L2 is reflected light of the detection light L radiated to the upper surface of the container C2. The third detection light L3 is reflected light of the detection light L radiated to the container yard G. Here, the third detection light L3 need not necessarily be captured clearly as long as the boundary with the second detection light L2 may be distinguished.

[0028]

As shown in Figs. 4A and 4B, the CCD camera 27 captures reflected light of the detection light L which is radiated toward the upper surface of the container C2 to be reflected therefrom. The CCD camera 27 captures the first detection light L1, the second detection light L2, and the third detection light L3.

The CCD camera 27 is spaced apart from the laser projector 25 and inclined with respect to the laser projector 25. For this reason, the first detection light L1, the second detection light L2, and the third detection light L3 are spaced apart from each other in a

direction corresponding to the X direction, and are captured.

[0029]

The container position determination unit 55 finds a position at which the container C1 gripped by the crane 5 should be arranged (a container arrangement position A) based on
5 the image data captured by the CCD camera 27.

Specifically, the container position determination unit 55 finds a vertical distance H1 between the CCD camera 27 and the container C2 based on a distance α from an image origin of the second detection light L2. In addition, the container position determination unit 55 finds a relative horizontal deviation amount D between the container C1 and the
10 container C2 based on a length β of the second detection light L2.

A distance and an angle (an inclination angle of the CCD camera 27) between the laser projector 25 and the CCD camera 27, and a viewing angle θ of the CCD camera 27 are already known.

As seen from Figs. 4A and 4B, α on the image lengthens as the vertical distance H1
15 shortens. In addition, since α is proportional to the actual distance H1, the distance may be easily calculated by previously setting values of inclinations and segments, which are obtained by previously measuring and finding the same, to the container position determination unit 55.

Furthermore, the horizontal deviation amount D may be obtained by the following
20 equation from an entire horizontal distance W of the image and the vertical distance H1:

$$D = 2 \times H1 \times \tan(\theta/2) \times (\beta/W).$$

[0030]

In addition, the container position determination unit 55 finds a vertical distance H2 between a lower surface of the container C1 gripped by the crane 5 and the container C2

from a distance γ on the image based on the image data captured by the CCD camera 27.

The distance H2 is easily found using the same proportional relationship as that in the distance H1. Here, since a typical container loading crane does not have a means for measuring the height of the holding container C1, there is no means for measuring a

5 distance required to place the container C1 on the container C2. In contrast, the container position determination unit 55 may accurately find the vertical distance between the container C1 and the container C2 based on the distance γ between the first detection light L1 and the second detection light L2 on the image. The container C1 may be placed on the container C2 with an optimal lowering speed pattern by obtaining
10 the vertical distance between the container C1 and the container C2. Consequently, it may be possible to shorten the operation time of the crane 5.

[0031]

Fig. 5A is a view showing the illumination light R radiated by the illuminator 26 when viewed from the X direction. Fig. 5B is a view showing the illumination light R

15 radiated by the illuminator 26 when viewed from the Y direction.

Fig. 6A is a view showing an image (an imaging range) captured by the CCD camera 27 of reflected light of the illumination light R when the vertical distance is long. Fig. 6B is a view showing an image (an imaging range) captured by the CCD camera 27 of reflected light of the illumination light R when the vertical distance is short.

20 [0032]

As shown in Figs. 5A and 5B, the illuminator 26 irradiates the container yard G with the illumination light R. The illumination light R is radiated to marks M1 installed in the container yard G.

Each of the marks M1 is a mark which corresponds to a container arrangement position B

25 and is provided in the container yard G. A diffusion plate is used as the mark M1.

Since light reflected by the mark M1 is diffused, the reflected light is always incident on the CCD camera 27. Therefore, the intensity of the reflected light (the illumination light R) captured by the CCD camera 27 does not easily change even when the illumination angle of the illumination light R with respect to the mark M1 changes.

5 Consequently, the mark M1, to which the illumination light R from the illuminator 26 is radiated, may be stably captured by the CCD camera 27.

In addition, since light reflected by the mark M1 is diffused, disturbance light such as sunlight is unlikely to be incident on the CCD camera 27. Consequently, the mark M1 may be stably captured by the CCD camera 27.

10 [0033]

The CCD camera 27 captures the illumination light R which is radiated toward the container yard G to be reflected therefrom. As shown in Figs. 6A and 6B, the CCD camera 27 captures the reflected light of the illumination light R reflected by the mark M1 in the container yard G.

15 [0034]

The container position determination unit 55 finds a position at which the container C1 gripped by the crane 5 should be arranged (a container arrangement position B) based on the image data captured by the CCD camera 27.

Specifically, the container position determination unit 55 finds a position of the mark M1 from a position of the reflected light of the illumination light R captured by the CCD camera 27. The container position determination unit 55 finds a container arrangement position B from positions of the mark M1 in the X and Y directions. The container position determination unit 55 finds a position at which the container C1 is placed and arranged.

25 [0035]

Here, a vertical distance (a position in the Z direction) between the ground (the container yard G) and the spreader 16 on which the container position detection apparatus 20 is installed is measured by a spreader position measuring device (not shown) to be known in advance. In addition, the distance between and the angle (an inclination angle of the
5 CCD camera 27) formed by the spreader 16 and the CCD camera 27, and a viewing angle of the CCD camera 27 are already known.

Therefore, the distances between the CCD camera 27 and the mark M1 in the X and Y directions are found geometrically from the mark positions P and Q on the image, and thus a relative distance between the container C1 and the container arrangement position
10 B is easily found.

[0036]

Fig. 7 is a view showing a state in which the detection light L of the laser projector 25 is radiated to containers C3.

As shown in Fig. 7, the containers C3 (the preinstalled adjacent containers) are adjacent
15 to the container arrangement positions A and B and are previously arranged in the container yard G. For this reason, when the container C1 is arranged at the container arrangement positions A and B by the crane 5, it is necessary that the container C1 not collide with the containers C3. Accordingly, the container position detection apparatus 20 irradiates the container C2 and the containers C3 with the detection light L from the
20 laser projector 25.

[0037]

As shown in Fig. 7, the detection light L is radiated so as to traverse an upper edge E each of the container C2 and the containers C3 which are previously arranged in the container yard G.

25 When the containers C3 are previously arranged in the container yard G, the CCD camera

27 captures fourth detection light L4 which is radiated to an upper surface of each container C3 to be reflected therefrom.

In the image data captured by the CCD camera 27, the fourth detection light L4 is captured at a different position from the first detection light L1, the second detection light
5 L2, and the third detection light L3. Therefore, the container position determination unit 55 may find a position of the upper edge E of the container C3 based on the position of the fourth detection light L4. When the container C1 is stacked or the like, the container position determination unit 55 may detect the presence of the container C3 serving as an obstacle.

10 Accordingly, the control apparatus 50 controls the crane 5 based on the position of the upper edge E of the container C3 found by the container position determination unit 55, thereby enabling a collision between the container C1 and the container C3 to be reliably prevented.

[0038]

15 Although an embodiment of the present invention has been described in detail, the present invention is not limited thereto and various modifications may be made in the embodiment without departing from the principles and spirit of the invention. That is, the specific shapes and configurations of the above embodiment are only examples and proper variations and modifications can be made.

20 [0039]

For example, although the above-mentioned embodiment describes that the total of four container position detection apparatuses 20 are installed on the long sides 16a and 16b of the spreader 16, the present invention is not limited thereto. The number and installation positions of container position detection apparatuses 20 can be arbitrarily set.

25 [0040]

The detection light L is not limited to sheet-shaped light in the Y direction. The detection light L may be sheet-shaped light in the X direction. Among the four container position detection apparatuses 20, two of the container position detection apparatuses 20 may radiate the sheet-shaped detection light L in the X direction and the remaining two container position detection apparatuses 20 may radiate the sheet-shaped detection light L in the Y direction. Thereby, four sides of the upper surface of the container C2 can be detected.

[0041]

Although the above-mentioned embodiment describes that the two rectangular-shaped marks M1 are arranged in the container yard G, the present invention is not limited thereto. The shapes and number of marks which correspond to the container arrangement position B and are provided in the container yard G can be arbitrarily set.

[Industrial Applicability]

15 [0042]

The present invention relates to a crane control system and a container position detection apparatus.

[Reference Signs List]

20 [0043]

1: crane control system

5: crane

10: crane gantry machine body

11: tire type gantry device

25 12: upper beam

- 13: trolley
- 14: hoisting device
- 15: wire
- 16: spreader
- 5 16a, 16b: long side
- 20: container position detection apparatus
- 25: laser projector (detection light irradiation unit)
- 26: infrared illuminator (illumination unit)
- 27: CCD camera (first or second imaging unit)
- 10 28: infrared transmission filter
- 50: control apparatus
- 55: container position determination unit
- G: container yard
- A, B: container arrangement position
- 15 C1: container
- C2: container (stacked container)
- C3: container (preinstalled adjacent container)
- E: upper edge
- L: detection light
- 20 L1: first detection light
- L2: second detection light
- L3: third detection light
- α , β , γ : deviation amount
- P, Q: position on image
- 25 M1: mark

R: illumination light

[CLAIMS]

[Claim 1]

A container position detection apparatus detecting a position which a holding container should be arranged in a container yard, the container position detection apparatus

5 comprising:

a detection light irradiation unit which radiates detection light from above so as to traverse an upper edge of a stacked container previously arranged in the container yard;

a first imaging unit which captures an irradiation range of the detection light obliquely from above to detect a first detection light radiated to the holding container and a second

10 detection light radiated to an upper surface of the stacked container; and

a container position determination unit which finds a container arrangement position based on the first detection light and the second detection light.

[Claim 2]

The container position detection apparatus according to claim 1, wherein the container

15 position determination unit finds a height of the upper edge of the stacked container based on a position of the second detection light detected by the first imaging unit.

[Claim 3]

The container position detection apparatus according to claim 1, wherein the container position determination unit finds a vertical distance between a lower end of the holding

20 container and the upper edge of the stacked container based on a deviation amount between a position of the first detection light and a position of the second detection light which are detected by the first imaging unit.

[Claim 4]

The container position detection apparatus according to any one of claims 1 to 3, further

25 comprising a second imaging unit which captures the container yard to detect a mark

corresponding to a container arrangement position provided in the container yard, wherein the container position determination unit finds the container arrangement position in the container yard based on a position of the mark.

[Claim 5]

- 5 The container position detection apparatus according to claim 4, wherein the first imaging unit is used as the second imaging unit.

[Claim 6]

The container position detection apparatus according to claim 4 or 5, further comprising an illumination unit which illuminates an imaging range of the second imaging unit.

- 10 [Claim 7]

The container position detection apparatus according to claim 6, wherein a wavelength band of each of the detection light and illumination light illuminated by the illumination unit is set to an atmospheric absorption band.

[Claim 8]

- 15 The container position detection apparatus according to any one of claims 1 to 7, wherein:
the detection light irradiation unit radiates the detection light so as to traverse an upper edge of a preinstalled adjacent container which is previously arranged so as to be adjacent to the container arrangement position; and
20 the container position determination unit detects a position of the preinstalled adjacent container.

[Claim 9]

A crane control system comprising:

a crane which moves a container in a container yard;

- 25 the container position detection apparatus according to any one of claims 1 to 8; and

a control apparatus which controls the crane based on the container arrangement position found by the container position detection apparatus.