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TITLE OF THE INVENTION

TROLLEY CAMERA POSITION DETECTING APPARATUS

FIELD OF THE INVENTION AND RELATED ART STATEMENT

5 The present invention relates to a position detecting apparatus for a trolley camera on a trolley for a container crane, for example, and can be applied to all machines for carrying a cargo lifted by a wire rope, such as a transfer crane, overhead crane, and the like.

10 Conventionally, a container crane etc. are used when cargoes piled on the ground are loaded on a ship alongside a pier or cargoes on a ship are unloaded and piled on the ground. In such cargo handling work, the cargo is controlled so that the swing of cargo is decreased, and the lifted cargo
15 is landed accurately at a target position by using a landing control device, described later.

 With the conventional landing control device, a cargo is hung with a lifting wire via a hoisting accessory, the crane is run to the target position along the rails in this
20 state, the trolley is moved to the target position along the girder, the swing amount of lifted cargo is subsequently detected by a sensor (the swing amount is detected as an inclination angle with respect to the vertical line by photographing a target on the hoisting accessory with a
25 camera installed on the trolley), and the movement of the

trolley is controlled based on this detection value, by which the swing of lifted cargo is made as small as possible, and the lifted cargo is landed at the time when the swing amount becomes within an allowable value.

5 For the above-mentioned landing control device for hoisting accessory, the trolley on the girder is first stopped correctly at a predetermined position, the swing amount of the hoisting accessory is then detected by a swing sensor, and swing stopping control is carried out based on
10 this detection value, by which the cargo is landed at the target position. The position of the trolley camera on the trolley at this time is successively detected by detecting the travel amount from the reference point provided on the girder by using an encoder (not shown).

15 However, if the deflection of the support leg or girder is changed, or a shift occurs between the crane wheel and the rail because of the movement of trolley on the girder or the change of the weight of lifted cargo, a shift of reference point on the girder is produced by the resultant horizontal
20 travel amount, which produces a measurement error, so that the detection accuracy of the trolley position or trolley camera position is worsened. As a result, the landing accuracy is also decreased.

25 OBJECT AND SUMMARY OF THE INVENTION

The present invention was made in view of such a situation, and accordingly an object thereof is to provide a trolley camera position detecting apparatus in which the position of a hoisting accessory is detected accurately, whereby the accuracy of landing position control can be increased.

To solve the problem with the above-described prior art, the present invention provides a trolley camera position detecting apparatus configured so that a trolley camera is installed on a trolley travelling on a girder, a leg target which runs together with a crane is provided at a position a predetermined distance apart from the center of a rail on which the crane runs, a girder camera is installed on the girder at a position a predetermined distance apart in the same way, an inclination angle θ_{cg} between the camera centerline and the leg target is measured by the girder camera, a clinometer is installed to the girder camera to measure an inclination angle θ_{kg} of the clinometer with respect to the vertical line, a horizontal travel amount δ_g of a reference point on the girder with respect to the rail center is measured by a measuring instrument, a constant value δ_o relating to the horizontal travel amount is calculated as

$$\delta_o = \delta_{go} - H_g(\theta_{cgo} - \theta_{kgo})$$

(where, H_g is a height from the leg target to the girder

camera)

in advance by using the initial values θ_{cgo} , θ_{kgo} , and δ_{go} of the measured values, and on the other hand, the inclination angles θ_{cg} and θ_{kg} are measured every moment during cargo

5 handling operation, a changing horizontal travel amount δ_g from the reference point on the girder is calculated as

$$\delta_g = \delta_o + H_g(\theta_{cg} - \theta_{kg})$$

by using these measured values θ_{cg} and θ_{kg} and the constant value δ_o , and the position of the trolley camera with the
10 rail center being a reference is corrected by using the horizontal travel amount δ_g .

With the trolley camera position detecting apparatus in accordance with the present invention, the inclination angle θ_{cg} between the camera centerline and the leg target at the
15 lower part of a leg is measured by the girder camera, the inclination angle θ_{kg} of the clinometer with respect to the vertical line is measured by the clinometer on the girder, the horizontal travel amount δ_g due to the inclination of crane leg on the rails is measured by a transit (measuring
20 instrument) etc., the constant value relating to the horizontal travel amount $\delta_o = \delta_{go} - H_g(\theta_{cgo} - \theta_{kgo})$ is calculated by using the initial values, the inclination angles θ_{cg} and θ_{kg} are measured every moment during cargo handling operation (during control), the horizontal travel amount of the
25 reference point on the girder $\delta_g = \delta_o + H_g(\theta_{cg} - \theta_{kg})$ is

calculated by using these measured values θ_{cg} and θ_{kg} and the constant value δ_0 , and the position (distance) δ is corrected by using δ_g thus calculated.

As described above, the trolley camera position
5 detecting apparatus in accordance with the present invention is configured so that the girder camera is installed to the girder, the clinometer is installed to the girder camera, the constant value relating to the horizontal travel amount of girder reference point is calculated in advance by using the
10 output values thereof, and on the other hand, the horizontal travel amount is calculated by using the output values of the girder camera and clinometer measured every moment and the constant value, and the position of the trolley camera with the rail center being the reference is corrected by using
15 this horizontal travel amount. Therefore, the position of hoisting accessory can be detected accurately, whereby the accuracy of landing position control of hoisting accessory can be increased.

20 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a trolley camera position detecting apparatus in accordance with one embodiment of the present invention;

FIG. 2 is a schematic view showing the whole of a
25 container crane equipped with the trolley camera position

detecting apparatus of this embodiment;

FIG. 3 is a schematic view showing a storage unit and an arithmetic unit provided in relation to the trolley camera position detecting apparatus of this embodiment; and

5 FIG. 4 is a flowchart showing a work procedure for detecting the position of trolley camera of this embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

10 The present invention will be described in detail in accordance with an embodiment shown in the drawings.

15 FIGS. 1 to 4 show one embodiment of a trolley camera position detecting apparatus in accordance with the present invention. The trolley camera position detecting apparatus of this embodiment is used for a container crane 1 shown in FIG. 2.

20 As shown in FIGS. 1 and 2, the container crane 1, which is a machine for loading cargoes (containers) 2 piled on the ground G onto a ship S alongside a pier or unloading cargoes 2 on the ship S onto the ground G, has a support leg 5 which is erected so as to be capable of running on a pair of rails 3 laid on the ground G via wheels 4, a girder 6 which is provided on top of the support leg 5 and extends horizontally perpendicular to the support leg 5, and a trolley 8 which is installed on the girder 6 so as to move while hanging a
25 hoisting accessory 7.

With such a container crane 1, a cargo 2 is lifted with a lifting wire 9 attached to the trolley 8 via the hoisting accessory 7, and in this state the trolley 8 is moved along the girder 6 or the support leg 5 is run along the rails 3 by driving the wheels 4 at the lower part of the support leg 5. Thereby, the lifted cargo 2 is carried to a predetermined position and landed at that position for loading/unloading.

On the other hand, a trolley camera 10 for measuring the swing amount of the hoisting accessory 7 is provided above the trolley 8 of the container crane 1 as shown in FIGS. 1 and 2. This trolley camera 10 is used for photographing a target 11 provided on the upper surface of the hoisting accessory 7 and detecting the swing amount by processing the image. When this detected value is sent to an arithmetic unit (not shown), a manipulated variable is calculated by the arithmetic unit, and the trolley 8 is controlled by the resultant manipulated variable, whereby the cargo 2 is landed after the swing of the cargo 2 is decreased.

The position of the trolley 8 on the girder 6 or the position of the trolley camera 10 is detected by an encoder (not shown) by taking a distance from a reference point O_1 set on the girder 6 to a camera centerline D as a horizontal travel amount Y_0 . In the present invention, the position (distance) of the trolley camera 10 is corrected by detecting

a horizontal travel amount δ_g of the reference point O_1 with a rail center C being a reference, which is caused by a change of the inclination of the support leg 5, a shift between the rail 3 and the wheel 4, and the like.

5 Also, a girder camera 12 for photographing a later-described leg target is installed so as to depend from the girder 6. This girder camera 12 is located at a position Y_c distant from the reference point O_1 . At the side of the girder camera 12, a clinometer 13 for measuring the
10 inclination angle protrudes horizontally. At the lower part of the support leg 5 located under the girder camera 12 by a height H_g , a leg target (for example, a laser target) 14 protruding horizontally is provided. This leg target 14 is located at a position Y_g distant from the rail center C.

15 The symbols in FIG. 1 denote the following:

Y_o : distance from the reference point on the girder to the trolley camera centerline

Y_g : distance from the rail center to the leg target

Y_c : distance from the rail center to the girder camera

20 a: intersection point of the vertical line passing through the rail center and the girder

δ_g : horizontal travel amount from the rail center to the reference point on the girder

H_g : height from the leg target to the girder camera

25 θ_{kg} : clinometer output value (rad) of the girder camera

θ_{cg} : output value (rad) of the girder camera

$\theta_{xg} = (\theta_{kg} - \theta_{cg}) - \theta_{yg}$ (rad)

θ_{yg} : angular difference (rad) between the girder camera centerline and the clinometer

5 δ : true trolley camera distance

A constant value δ_0 and the measured value of height H_g are sent and stored in a storage unit 15 and then sent to an arithmetic unit 16 as shown in FIG. 3. Also, the measured value of distance Y_0 and the output values θ_{cg} and θ_{kg} are sent
10 to the arithmetic unit 16. The true distance δ of the trolley camera 10 is calculated based on these values sent to the arithmetic unit 16.

For the trolley camera position detecting apparatus of this embodiment, the true position (distance) δ of the
15 trolley camera 10 is detected by the work procedure shown in FIG. 4.

First, the inclination angle θ_{cg} between the camera centerline E and the leg target 14 is measured, and the inclination angle (installation angle) θ_{kg} with respect to
20 the vertical line is measured by using the clinometer 13.

In FIG. 1,

$$H_g \theta_{xg} = Y_c - Y_g - \delta_g \quad (1)$$

$$\theta_{xg} = (\theta_{kg} - \theta_{cg}) - \theta_{yg} \quad (2)$$

Multiplying both sides of Eq. (2) by H_g ,

25 $H_g \theta_{xg} = H_g(\theta_{kg} - \theta_{cg}) - H_g \theta_{yg} \quad (3)$

From Eqs. (1) and (3),

$$\delta_g = H_g(\theta_{cg} - \theta_{kg}) + H_g\theta_{yg} - Y_g + Y_c \quad (4)$$

Here, θ_{yg} is constant because it is the angular difference between the camera centerline E of the girder camera 12 and the inclination angle of the clinometer 13, Y_g is constant because it is the distance between the rail center C of the rail 3 and the leg target 14, and Y_c is also constant because it is the distance between the reference point O_1 and the camera centerline E of the girder camera 12.

Therefore, Eq. (4) indicates that the horizontal travel amount δ_g can be calculated by the output θ_{cg} of the girder camera 12 and the output θ_{kg} of the clinometer 13.

If the amount (constant value: $H_g\theta_{yg} - Y_g + Y_c$) independent of the change of horizontal travel amount is taken as δ_o , the horizontal travel amount can be expressed as

$$\delta_g = \delta_o + H_g(\theta_{cg} - \theta_{kg}) \quad (5)$$

Thus, by substituting the respective initial values θ_{cgo} , θ_{kgo} , and δ_{go} of the aforesaid θ_{cg} , θ_{kg} , and δ_g measured under the same lifted cargo condition into Eq. (5), the constant value δ_o can be calculated as

$$\delta_o = \delta_{go} - H_g(\theta_{cgo} - \theta_{kgo}) \quad (6)$$

Thereupon, the output θ_{cg} of the girder camera 12 and the output θ_{kg} of the clinometer 13 are measured every moment during cargo handling operation (during control), the horizontal travel amount δ_g of the reference point O_1 is

successively calculated by substituting these measured values and the initial value δ_0 into Eq. (5), the true distance δ ($\delta = Y_0 + \delta_g$) of the trolley camera 10 is calculated by the arithmetic unit 16 using the calculated value δ_g and the distance Y_0 , and the position of the trolley camera 10 is corrected. If the position is corrected in such a manner, the accuracy of the landing position control of the hoisting accessory 7 can be enhanced.

The above is a description of one embodiment of the present invention. The present invention is not limited to the above-described embodiment, and various modifications and changes can be made on the basis of the technical concept of the present invention.

For example, the initial value δ_{g0} of the horizontal travel amount of the reference point on the girder with respect to the rail center C in the above-described embodiment can be measured by measuring means such as a transit provided in the vicinity of the base of the support leg 5. Also, if the angular difference θ_{yg} between the camera and the clinometer can be measured by some method, the constant value δ_0 can be determined directly together with other measured distances H_g , Y_g , and Y_c .

CLAIMS

(1) A trolley camera position detecting apparatus configured so that a trolley camera is installed on a trolley travelling on a girder, a leg target which runs together with a crane is provided at a position a predetermined distance apart from the center of a rail on which the crane runs, a girder camera is installed on the girder at a position a predetermined distance apart in the same way, an inclination angle θ_{cg} between the camera centerline and the leg target is measured by the girder camera, a clinometer is installed to the girder camera to measure an inclination angle θ_{kg} of the clinometer with respect to the vertical line, a horizontal travel amount δ_g of a reference point on the girder with respect to the rail center is measured by a measuring instrument, a constant value δ_o relating to the horizontal travel amount is calculated as

$$\delta_o = \delta_{go} - H_g(\theta_{cgo} - \theta_{kgo})$$

(where, H_g is a height from the leg target to the girder camera)

in advance by using the initial values θ_{cgo} , θ_{kgo} , and δ_{go} of the measured values, and on the other hand, the inclination angles θ_{cg} and θ_{kg} are measured every moment during cargo handling operation, a changing horizontal travel amount δ_g from the reference point on the girder is calculated as

$$\delta_g = \delta_o + H_g(\theta_{cg} - \theta_{kg})$$



by using these measured values θ_{cg} and θ_{kg} and the constant value δ_0 , and the position of the trolley camera with the rail center being a reference is corrected by using the horizontal travel amount δ_g .

5 (2) A trolley camera position detecting apparatus according to claim (1), wherein the constant value δ_0 relating to the horizontal travel amount and the measured value of height H_g are sent to an arithmetic unit after being sent and stored in a storage unit, and the measured value of
10 a distance Y_0 from the reference point on the girder to the trolley camera centerline and the measured values of inclination angles θ_{cg} and θ_{kg} are sent to the arithmetic unit.

