

CONTROL DEVICE AND METHOD FOR CONTROLLING GARBAGE CRANE

BACKGROUND OF THE INVENTION

Field of the Invention

5 [0001]

The present disclosure relates to a control device and a method for controlling a crane. The present disclosure claims priority based on Japanese Patent Application No. 2024-122443 filed in Japan on July 29, 2024, the contents of which are incorporated herein by reference.

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Description of Related Art

[0002]

Garbage transported to a garbage incineration facility is thrown into and stirred in a receiving source area of a pit from a garbage collection vehicle, and thereafter, the garbage is input to a hopper. Japanese Patent No. 7161642 discloses controlling for switching works of a crane to any of "unloading", "receiving", or "transferring" in response to a height or the like of a garbage pile deposited in the receiving source area. Japanese Patent No. 7161642 does not disclose a technology for preventing a possibility that the garbage overflows after the height of the garbage pile deposited in the receiving source area exceeds a threshold value.

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SUMMARY OF THE INVENTION

[0004]

According to an aspect of the present disclosure, there is provided a method for controlling a garbage crane which can prevent an overflow of a garbage pile height in a

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receiving source area of a garbage pit.

[0005]

The present disclosure provides a control device and a method for controlling a garbage crane which can achieve the above-described aspect.

5 [0006]

According to an aspect of the present disclosure, there is provided a control device including means for determining an operation mode. When an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving
10 destination area, and an operation of transporting the garbage from the receiving source area to the receiving destination area is defined as receiving, the operation mode is determined, based on an increase amount of a garbage pile height in the receiving source area corresponding to a value obtained by subtracting a transport amount of garbage from the receiving source area to the receiving destination area per unit time from the amount
15 of the garbage input to the receiving source area per unit time, and an automatic determination logic of the operation mode of the receiving in which the increase amount of the garbage pile height in the receiving source area is associated with a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

20 [0007]

According to another aspect of the present disclosure, there is provided a method for controlling a garbage crane. The method includes determining an operation mode, and receiving garbage in the determined operation mode. When an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to
25 which the garbage is transported from the receiving source area is defined as a receiving

destination area, and an operation of transporting the garbage from the receiving source area to the receiving destination area is defined as receiving, the operation mode is determined, and the garbage is received in the determined operation mode, based on an increase amount of a garbage pile height in the receiving source area corresponding to a value obtained by subtracting a transport amount of garbage from the receiving source area to the receiving destination area per unit time from the amount of the garbage input to the receiving source area per unit time, and an automatic determination logic of the operation mode of the receiving in which the increase amount of the garbage pile height in the receiving source area is associated with a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

[0008]

According to a control device and a method for controlling a garbage crane in the present disclosure, it is possible to prevent an overflow of a garbage pile height in a garbage receiving source area.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a schematic view of a garbage treatment plant according to an embodiment.

20 FIG. 2 is a first diagram showing an operation mode of the embodiment.

FIG. 3 is a second diagram showing an operation mode of the embodiment.

FIG. 4 is a first diagram showing an operation mode automatic switching logic of the embodiment.

FIG. 5 is a first diagram showing an example of the operation mode automatic switching according to the embodiment.

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FIG. 6 is a second diagram showing the operation mode automatic switching logic of the embodiment.

FIG. 7 is a second diagram showing an example of the operation mode automatic switching according to the embodiment.

5 FIG. 8 is a third diagram showing the operation mode automatic switching logic of the embodiment.

FIG. 9 is a flowchart showing an example of an automatic operation mode switching process of the embodiment.

10 FIG. 10 is a diagram showing an example of the hardware configuration of a control device of the embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0010]

<Embodiment>

15 Hereinafter, a method for controlling a crane of a garbage treatment plant of the present disclosure will be described with reference to FIGS. 1 to 10.

(Configuration)

FIG. 1 is a schematic view of a garbage treatment plant according to an embodiment.

20 As shown in FIG. 1, a garbage treatment plant 100 includes a crane system 1, a pit 2, a hopper 3, a platform 5, and a control device 10. The pit 2 is a facility that stores garbage transported by a garbage collection vehicle 6. FIG. 1 is a schematic view when the pit 2 is viewed from above. The hopper 3 is a garbage input port for delivering the garbage to an incinerator (not shown). The garbage is input to the hopper 3 by the crane
25 system 1. The crane system 1 is provided with cranes C1 and C2 that perform

operations such as stirring and transporting of the garbage. The cranes C1 and C2 are disposed to be movable on rails R1 and R2, and cannot perform operations such as a movement of the crane C1 to a right side of a paper surface by overtaking the crane C2, or a movement of the crane C2 to a left side of the paper surface with respect to the crane

5 C1. Various operations of the crane system 1 are controlled by the control device 10.

The control device 10 moves the cranes C1 and C2 in a left-right direction and an up-down direction of the paper surface and in a front-back depth direction of the paper surface to carry out work such as inputting, receiving, and stirring. The inputting, receiving, and stirring will be described later, but controlling in the present embodiment

10 mainly relates to the receiving. The platform 5 is an area for the garbage collection vehicle 6 to input the garbage to the pit 2. The garbage collection vehicle 6 transports the garbage, arrives at the platform 5, and throws the garbage toward the pit 2. The thrown garbage is dropped into a region 2c of the pit 2, and is transported to a region 2a or a region 2b by the cranes C1 and C2. Doors 4a to 4e are provided on a wall surface

15 near the region 2c, and the garbage can be input to the region 2c from the garbage collection vehicle 6 only when the doors 4a to 4e are open. For example, roles of the region 2a and the region 2b are replaced with each other every day. For example, on a certain day, the region 2a plays a role as an input source that supplies the garbage to be

input to hoppers 3a and 3b, and the region 2b plays a role of receiving the garbage input

20 from the garbage collection vehicle 6. In this case, the region 2a will be referred to as an input area, and the region 2b will be referred to as a receiving destination area. In

addition, the region 2c will be referred to as a receiving source area. On the next day,

the garbage input to the region 2c is transported to the region 2a, and the garbage is input to the hoppers 3a and 3b from the region 2b. In this case, the region 2a is the receiving

25 destination area, the region 2b is the input area, and the region 2c is the receiving source

area without any change.

[0011]

Hereinafter, a lateral direction of the paper surface will be referred to as a row, and a longitudinal direction will be referred to as a column. Each region obtained by dividing the pit 2 into 8 rows and 14 columns as in an example in the drawing will be referred to as a cell. For example, a cell in a row A and a first column is described as a cell (A, 1). In the pit 2 shown in FIG. 1, the region 2a is set to a range of 5 cells $\times$ 5 cells of rows A to E and columns 9 to 13, and the region 2b is set to a range of 5 cells $\times$ 5 cells of the rows A to E and columns 3 to 7. However, these are merely examples, and a user can optionally set a position or a range of the regions 2a and 2b.

[0012]

(Inputting)

Inputting represents work for inputting the garbage to the hoppers 3a and 3b. The hoppers 3a and 3b are provided with sensors that measure a height of the garbage which indicates the amount of the garbage stored inside the hopper. When the height of the garbage is equal to or lower than a certain level, the amount of the garbage supplied to an incinerator (not shown) is insufficient. In this case, the control device 10 controls the crane C1 to input the garbage in the pit 2 to the hopper 3a. The same applies to the hopper 3b. When the height of the garbage inside the hopper is equal to or higher than the certain level, it is not necessary to further input the garbage. In this case, the control device 10 does not input the garbage to the hoppers 3a and 3b.

[0013]

(Receiving)

Receiving is work for transporting the garbage thrown into the receiving source area (region 2c) to the receiving destination area (region 2a or 2b). The height of the

garbage in each cell of the pit 2 is managed. For example, a sensor that measures the height of the garbage of each cell may be provided on a wall surface, a ceiling, an upper space, and the like of the pit 2. The height of the garbage may be measured by the sensor, or may be obtained by estimation from the amount of the garbage transported by the cranes C1 and C2. When a height of a garbage pile in the receiving source area (region 2c) is equal to or greater than a predetermined threshold value, inputting the garbage from the garbage collection vehicle 6 is affected. Therefore, it is necessary to quickly move the garbage to another place inside the pit 2. For example, when the height of the garbage of the cell (H, 8) is equal to or greater than the threshold value, and the region 2b is the receiving destination area, the control device 10 moves the crane C1 or C2 to the cell (H, 8) to transport the garbage of the cell (H, 8) to the receiving destination area (region 2b). This work will be referred to as the "receiving". During the receiving, for example, the control device 10 calculates an average value of the heights of the garbage in each column of the region 2b from the height of the garbage in each cell of the region 2b, selects a column having a lowest average value of the height of the garbage, and evenly drops the garbage transported from the cell (H, 8) to all cells of selected columns (scattering). The height of the garbage in each cell after the garbage is dropped is obtained and managed by measurement or calculation. In addition, a total evaluation point representing the stirring state of the garbage in each cell after the garbage is dropped is calculated, and the total evaluation point is managed for each cell. Any method can be applied as a method for calculating the total evaluation point. For example, the total evaluation point may be calculated by a calculation formula in which a higher total evaluation point is assigned as the number of times of stirring is larger.

(Stirring)

Stirring is work for causing the cranes C1 and C2 to pick up the garbage of a certain cell, dropping the garbage into the same cell, or transporting and dropping the garbage into another cell. The garbage stored in the regions 2a and 2b is stirred so that the garbage in each cell is in a state suitable for uniform combustion. The total evaluation point of the cell is updated each time stirring is performed. The stirring is performed preferentially from the cell having a low total evaluation point, and the stirring may not be performed for the cell in which the total evaluation point is equal to or greater than a predetermined threshold value indicating that the total evaluation point is in a state where the cell can be input to the hoppers 3a and 3b.

[0015]

In the receiving source area, the garbage is continuously thrown from the garbage collection vehicle 6, and when the receiving is not performed, the height of the garbage pile in the receiving source area overflows. However, when only the receiving is performed, the garbage remains in a state unsuitable for combustion in the incinerator. Therefore, in the present embodiment, the cranes C1 and C2 are controlled such that the total evaluation point of the garbage in the receiving destination area can be improved while the overflow of the garbage pile height in the receiving source area is prevented. More specifically, the cranes C1 and C2 are controlled to automatically switch operation modes of the cranes C1 and C2, based on an average increase amount of the garbage pile height in the receiving source area or (garbage input amount - receiving speed), and to perform stirring when a margin is available while the receiving is appropriately performed.

[0016]

(Function and Configuration of Control Device)

The control device 10 includes a signal acquisition unit 11, an operation mode determination unit 12, a control unit 13, and a storage unit 14.

The signal acquisition unit 11 acquires a signal including an input amount (t/h) of the garbage thrown into the region 2c (referred to as a garbage input amount) and a
 5 signal including a transport amount (t/h) of the garbage transported from the region 2c to the region 2a or the region 2b (referred to as a receiving speed). In addition, the signal acquisition unit 11 acquires a signal including the garbage pile height in the receiving source area (region 2c). For example, the signal acquisition unit 11 receives a signal including the garbage input amount and the receiving speed or a signal including the
 10 garbage pile height every hour, and records information on the garbage input amount or the receiving speed included in the received signal in the storage unit 14. The receiving speed can be calculated by the number of times of receiving (times/h) $\times$ a weight of the garbage picked in one receiving (t/time). In addition, the signal acquisition unit 11 may acquire a signal including information related to a congestion degree of the platform 5
 15 (for example, the number of garbage collection vehicles 6 existing in the platform 5).

[0017]

The operation mode determination unit 12 determines an operation mode related to the receiving of the cranes C1 and C2. Here, an example of the operation mode related to the receiving will be described with reference to FIGS. 2 and 3. As will be
 20 described below, in each operation mode, a range or a position where the garbage is dropped is defined in the receiving destination area. When the range where the garbage is dropped is wide, an advantageous effect of homogenizing the garbage in each cell to a state suitable for combustion can be expected, and when the position where the garbage is dropped is close to the receiving source area, the garbage can be transported as many
 25 times as possible. Therefore, improvement in the receiving speed can be expected.

[0018]

[Stirring Receiving Mode]

A stirring receiving mode is an operation mode for repeating an operation in which the garbage is picked and scattered to a back side of the pit 2, x-times, and the garbage is stirred, y-times. In a case of the stirring receiving mode, as shown in FIG. 2, for example, the crane C1 or C2 performs a scattering operation in which the garbage in the cell (H, 11) is picked and evenly dropped into each cell of the six columns in the region 2b, x-times, and performs the stirring operation in which the garbage in the cell (E, 6) is picked and dropped into the cell (A, 3), y-times. The cell (H, 11), the 6 columns, the cell (E, 6), and the cell (A, 3) in this example are merely examples, and other cells or columns may be included in the x-times of scattering and the y-times of stirring. The same applies to other operation modes described below. The stirring receiving mode is an operation mode in which the degree of stirring the garbage is high and the receiving speed of the garbage is low.

15 [0019]

[Normal Receiving Mode]

A normal receiving mode is an operation mode for repeating an operation in which the garbage is picked and scattered to the back side of the pit 2. In a case of the normal receiving mode, as shown in FIG. 2, for example, the crane C1 or C2 repeatedly performs a scattering operation in which the garbage in the cell (H, 11) is picked and evenly dropped into each cell of the 6 columns in the region 2b. The normal receiving mode is an operation mode in which the degree of stirring the garbage is medium to high and the receiving speed of the garbage is low.

[0020]

25 [Semi-Busy Mode]

A semi-busy mode is an operation mode for repeating an operation in which the garbage is picked and dropped at a specific position. In a case of the semi-busy mode, as shown in FIG. 3, for example, the crane C1 or C2 performs an operation in which the garbage of the cell (H, 11) is picked and dropped into the cell (D, 6) in a certain unit
 5 time. The semi-busy mode is an operation mode in which the degree of stirring the garbage is medium and the receiving speed of the garbage is moderate.

[0021]

[Busy Mode]

A busy mode is an operation mode for repeating an operation in which the
 10 garbage is picked and dropped into a nearby area. In the busy mode, as shown in FIG. 3, for example, the crane C1 or C2 performs an operation in which the garbage in the cell (H, 11) is picked and dropped into any cell of the region 2a in a certain unit time. The busy mode is an operation mode in which the degree of stirring the garbage is low and the receiving speed of the garbage is high.

15 [0022]

When these operation modes are aligned in descending order of the stirring degree (homogenized degree in a state suitable for combustion) as follows: the stirring receiving mode, the normal receiving mode, the semi-busy mode, and the busy mode. In addition, when these operation modes are aligned in descending order of the receiving
 20 speed as follows: the busy mode, the semi-busy mode, the normal receiving mode, and the stirring receiving mode.

[0023]

Through tests and studies of the inventor, the following has been found.
 (garbage input amount - receiving speed) per unit time (for example, one hour) and an
 25 average value of the increase amount of the garbage pile height in the region 2c

(receiving source area) have a linear relationship L1 as shown in FIG. 4(a). In FIG. 4(a), the vertical axis represents the "average increase amount of the garbage pile height (m/h)", and the horizontal axis represents the "(garbage input amount - receiving speed) per hour". When this relationship is used, from the graph in FIG. 4(a), when the

5 "(garbage input amount - receiving speed) per hour" at 10:00 is x_1 (t/h), the "average increase amount (m/h) of the garbage pile height" is 0.5, and the garbage pile height at 10:00 can be estimated as follows.

An estimation value of garbage pile height (m) at 10:00 = garbage pile height (m) at 9:00 + 0.5 (m)

10 The operation mode determination unit 12 uses this relationship to automatically switch the operation modes, and prevent the overflow of the height of the garbage pile in the region 2c.

[0024]

The control unit 13 controls the cranes C1 and C2, based on the operation mode

15 determined by the operation mode determination unit 12. In the present embodiment, automatic switching of the operation mode when the receiving is selected as the work to be carried out by the cranes C1 and C2 will be described. The control unit 13 determines which work for receiving, stirring, inputting, or the like is to be performed in accordance with a predetermined control logic, and when the receiving is performed, the

20 control unit 13 performs receiving in the operation mode selected by an automatic switching function of the operation mode of the present embodiment.

[0025]

The storage unit 14 stores information acquired by the signal acquisition unit 11, the total evaluation point of each cell, a graph (FIG. 4(a) and the like) showing a

25 relationship between (garbage input amount - receiving speed) per hour and the increase

amount of the average value of the garbage pile height, an operation mode automatic determination logic (FIG. 4(b) and the like), various threshold values, and the like.

[0026]

(Method for Determining Operation Mode)

5 Next, a method for determining the operation mode will be described with reference to FIGS. 4 to 8.

FIG. 4(a) shows the linear relationship L1 between the average increase amount of the garbage pile height and (garbage input amount - receiving speed) per hour. FIG. 4(b) shows the automatic determination logic of the operation mode. A vertical axis in
 10 FIG. 4(b) represents the operation mode, and a horizontal axis represents the average increase amount of the garbage pile height. The graph in FIG. 4(b) shows a threshold value of operation mode automatic switching. When the average increase amount of the garbage pile height has a value corresponding to an upward line indicated by a solid line, the mode is switched to a one stage upper operation mode in which the receiving speed is
 15 high, and when the average increase amount of the garbage pile height has a value corresponding to a downward line indicated by a broken line, the mode is switched to a one stage lower operation mode in which the receiving speed is low. A dead zone is provided in the automatic determination logic to prevent chattering at a threshold value boundary. Numerical values such as the number of the operation modes and the
 20 threshold value are merely examples, and can be set in any ways.

[0027]

Next, an example of the automatic switching of the operation mode will be described with reference to FIG. 5. In FIG. 5, a vertical axis indicates the height of the garbage pile in the receiving source area (region 2c), and a horizontal axis indicates a
 25 time. The operation mode determination unit 12 determines the operation mode through

the following procedure.

(1) A threshold value Th1 (FIG. 5) based on the garbage pile height in the receiving source area is provided, an automatic operation mode switching function is turned on when the garbage pile height exceeds the threshold value Th1, and the
 5 automatic operation mode switching function is turned off when the garbage pile height is equal to or smaller than the threshold value Th1.

(2) When the operation mode automatic switching function is turned on, the increase amount (m/h) of the average value of the garbage pile height is calculated by using (garbage input amount - receiving speed) (t/h) per unit time (for example, one
 10 hour) and the linear relationship L1 in FIG. 4(a). Next, the operation mode corresponding to the calculated increase amount of the average value of the garbage pile height is determined with reference to the threshold value of the automatic determination logic in FIG. 4(b).

[0028]

15 (Operation Mode Automatic Switching during Daytime)

In an example in FIG. 5, the height of the garbage pile at 09:00 is equal to or smaller than the threshold value Th1. Therefore, the operation mode determination unit
 12 turns off the operation mode automatic switching function. The operation mode determination unit 12 determines the operation of the cranes C1 and C2 related to the
 20 receiving as a predetermined operation mode.

[0029]

At 10:00, the height of the garbage pile exceeds the threshold value Th1. Therefore, the operation mode determination unit 12 turns on the operation mode automatic switching function. Here, when (garbage input amount - receiving speed) at
 25 10:00 is x_0 (t/h) in FIG. 4(a), the average increase amount of the garbage pile height

corresponding to x_0 is 0.0 or smaller. Therefore, the operation mode determination unit 12 determines the operation mode as the stirring receiving mode from the automatic determination logic in FIG. 4(b).

[0030]

5 At 11:00, the height of the garbage pile exceeds the threshold value Th_1 .

Therefore, the operation mode determination unit 12 turns on the operation mode automatic switching function. Here, when (garbage input amount - receiving speed) at 11:00 is x_2 (t/h) in FIG. 4(a), the average increase amount of the garbage pile height corresponding to x_2 exceeds 2.0. Therefore, the operation mode determination unit 12
10 switches the operation mode to the busy mode with reference to the automatic determination logic in FIG. 4(b).

[0031]

At 12:00, the height of the garbage pile exceeds the threshold value Th_1 .

Therefore, the operation mode determination unit 12 turns on the operation mode
15 automatic switching function. Here, when (garbage input amount - receiving speed) at 12:00 is x_3 (t/h) in FIG. 4(a), the average increase amount of the garbage pile height corresponding to x_3 is smaller than 0.0. Therefore, the operation mode determination unit 12 switches the operation mode to the stirring receiving mode with reference to FIG. 4(b). In this manner, not only scattering but also stirring is performed. When there is
20 no big change in the value of (garbage input amount - receiving speed) even at 13:00, the stirring receiving mode is continuously selected.

[0032]

At 14:00, the height of the garbage pile exceeds the threshold value Th_1 .

Therefore, the operation mode determination unit 12 turns on the operation mode
25 automatic switching function. In addition, at 14:00, the height of the garbage pile

exceeds a threshold value Th2. The threshold value Th2 is a threshold value for detecting that the garbage pile height is close to the overflow. When the garbage pile height exceeds the threshold value Th2, the operation mode determination unit 12 determines the operation mode, based on another automatic determination logic different from that in FIG. 4(b). FIG. 6 shows an example of the automatic determination logic of the operation mode adopted when the height of the garbage pile in the receiving source area exceeds the threshold value Th2. FIG. 6(a) shows the same linear relationship L1 as that in FIG. 4(a), but a range of the dead zone is different from that in FIG. 4(a).

When the height of the garbage pile is high (close to the overflow), the threshold value of the operation mode determination is corrected in the automatic determination logic in FIG. 6(b) so that a higher mode (mode in which the receiving speed is high) is selected even when the average increase amount (m/h) of the garbage pile height is small. For example, in a case of FIG. 4(b), the busy mode is not selected unless the average increase amount of the garbage pile height is 2.0 or more. However, in a case of FIG. 6(b), the threshold value is corrected to select the busy mode when the average increase amount of the garbage pile height is 1.5 or more. In this manner, when close to the overflow, the mode can be changed to the operation mode close to a human determination trying to improve the receiving speed to avoid the overflow. The magnitude of correction from the automatic determination logic shown in FIG. 4(b) to the automatic determination logic shown in FIG. 6(b) can be adjusted.

[0033]

Here, when (garbage input amount - receiving speed) at 14:00 is x4 in FIG. 6(a), the average increase amount of the garbage pile height corresponding to x4 exceeds 1.5. Therefore, the operation mode determination unit 12 switches the operation mode to the busy mode with reference to FIG. 6(b). In this manner, the receiving speed is improved.

[0034]

Next, when (garbage transport amount - receiving speed) at 15:00 is x5 in FIG. 6(a), the average increase amount of the garbage pile height corresponding to x5 is smaller than 1.5. However, the average increase amount exceeds 1.0, and thus, reaches the dead zone. The operation mode determination unit 12 maintains the operation mode in the busy mode with reference to FIG. 6(b). In this manner, the receiving in the busy mode is performed until 16:00. As an example, the garbage is completely input at 16:00, and thereafter, a maintenance period is set until 17:00.

[0035]

(Operation Mode Automatic Switching at Night)

Next, an operation mode at night (after 17:00) during which the garbage is not input will be described. Since (garbage input amount - receiving speed) is 0 or smaller until the next morning after the garbage is completely input, the operation mode determination unit 12 determines the operation mode as the stirring receiving mode with reference to FIG. 4(b). The stirring receiving mode is an operation in which the stirring is performed y-times for each of the x-times of receiving. However, the x-times and the y-times can be set in any ways. For example, a user sets the x-times and the y-times in the control device 10 in accordance with the height of the garbage pile in the receiving area at the garbage input completion time, the day of the week, or the like, and the control unit 13 performs the receiving in the stirring receiving mode, based on the set x-times and the set y-times. FIG. 7 shows an example of a transition of the garbage pile height at night. The vertical axis in FIG. 7 indicates the height of the garbage pile in the receiving source area, and the horizontal axis indicates the time. A graph 71 shows a transition of the garbage pile height when the garbage pile height at the input completion time is high, and a graph 72 shows a transition of the garbage pile height when the

garbage pile height at the input completion time is low. When the garbage pile height is high, the number of x-times is increased and the number of y-times is decreased. In this manner, the garbage pile height on the next morning can be reduced. In addition, when the garbage pile height is low, the number of y-times is increased and the stirring is

5 increased. In this way, a state of the garbage can be brought into a state suitable for combustion. In general, in many cases, the following operations are performed. At night, the garbage is first moved and spread (scattered) from the receiving source area to the receiving destination area, and thereafter, the garbage is stirred in the morning. In this case, the garbage in an upper layer portion of the receiving destination area is stirred,

10 but the garbage on a relatively inner layer where the garbage is moved and spread at the beginning of the night is deposited while the garbage is not stirred. In contrast, according to the present embodiment, the stirring receiving mode is selected, and the operation of setting the x-times of scattering and the y-times of stirring is performed through the night. Therefore, the garbage can be deposited in a state where the garbage

15 not only on the upper layer but also on the internal layer is stirred. In this way, the automatic switching of the operation mode according to the present embodiment is applied to the receiving such that determination of an operator of the cranes C1 and C2 is not required, and an optimal operation mode is selected. Therefore, the total evaluation point of the receiving destination area can be raised while the overflow of the receiving

20 source area is automatically prevented. In addition, both receiving completion and raising the total evaluation point can be achieved during the night from the transport completion to the next morning.

[0036]

(Another Example of Automatic Determination Logic)

25 In FIGS. 4 and 5, an example in which the operation mode is switched based on

the average increase amount of the garbage pile height has been described. Meanwhile, in addition to this example, the average increase amount of the garbage pile height per hour may be calculated in accordance with a congestion degree of the platform 5, or the operation mode may be automatically switched. FIG. 8(a) shows a relationship between the congestion degree of the platform 5 and the average increase amount (m/h) of the garbage pile height per hour. As in FIGS. 4(a) and 5(a), a linear relationship L2 is obtained between both of these. As the congestion degree of the platform, for example, a reference may be determined such that the congestion degree is "none" when the number of the garbage collection vehicles 6 existing in the platform 5 is 0, the congestion degree is "mild" when the number of the garbage collection vehicles 6 is 1 to 3, the congestion degree is "moderate" when the number of the garbage collection vehicles 6 is 4 to 6, the congestion degree is "severe" when the number of the garbage collection vehicles 6 is 7 or more, and the like, and the operation mode determination unit 12 may calculate the congestion degree of the platform 5 in accordance with the reference. The operation mode determination unit 12 can calculate the congestion degree of the platform 5 and the average increase amount of the garbage pile height per hour from a graph in FIG. 8(a), and can determine the operation mode, based on the calculated average increase amount of the garbage pile height and the automatic determination logic shown as an example in FIGS. 4(b) and 5(b). In addition, when the operation mode determination unit 12 calculates the congestion degree of the platform 5, the operation mode determination unit 12 may determine the operation mode, based on an automatic determination logic shown as an example in FIG. 8(b). For example, when the congestion degree is mild, the operation mode determination unit 12 selects the normal receiving mode, and when the congestion degree is moderate, the operation mode determination unit 12 selects the semi-busy mode. With regard to the dead zone, the

dead zone may be set in accordance with the number of the garbage collection vehicles 6 existing in the platform 5. For example, such that the operation mode is changed to the busy mode (7 vehicles or more), the operation mode is thereafter changed to the semi-busy mode when the number of the garbage collection vehicles 6 existing in the platform 5 is reduced to five from the state of the busy mode, and the operation mode is further changed to the normal receiving mode when the number of the garbage collection vehicles 6 existing in the platform 5 is reduced to two. In the present example, the number of categories of the congestion degree is not limited to four. In addition, in FIGS. 4(b) and 5(b), the operation mode is determined in accordance with the average increase amount of the garbage pile height per hour. Meanwhile, the garbage input amount - receiving speed per hour may be set in the horizontal axis in FIGS. 4(b) and 5(b), the automatic determination logic in which a relationship between the garbage input amount - receiving speed per hour and the operation mode is defined may be prepared, and the operation mode may be directly determined, based on the garbage input amount - receiving speed.

[0037]

(Operation)

Next, a flow of an automatic switching process of the operation mode will be described with reference to FIG. 9.

FIG. 9 is a flowchart showing an example of the automatic operation mode switching process of the embodiment.

The operation mode determination unit 12 repeats the following process for each unit time. First, the operation mode determination unit 12 determines whether the garbage pile height in the receiving source area is equal to or smaller than the threshold value Th1 (Step S1). When the garbage pile height is equal to or smaller than the

threshold value Th1 (Step S1; Yes), the operation mode determination unit 12 turns off the automatic operation mode switching function, and sets the operation mode of the receiving to the normal stirring mode (Step S2). Here, the normal stirring mode may be an operation mode including not only receiving (moving and spreading, scattering) but also a lot of stirring, since a margin is available until the overflow of the garbage pile height. For example, the normal stirring mode may be the same operation as the stirring receiving mode.

[0038]

When the garbage pile height exceeds the threshold value Th1 (Step S1; No), the operation mode determination unit 12 turns on the automatic operation mode switching function (Step S3). Next, the operation mode determination unit 12 determines whether to select the stirring receiving mode, based on the previous garbage input amount - receiving speed per unit time, the average increase amount of the garbage pile height per unit time, or the current congestion degree of the platform 5, and the automatic determination logic in FIGS. 4(b) and the like (Step S4). When the garbage input amount - receiving speed per unit time, or the like satisfies a condition of the stirring receiving mode (Step S4; Yes), the operation mode determination unit 12 determines the operation mode of the receiving as the stirring receiving mode (Step S5).

[0039]

When the condition of the stirring receiving mode is not satisfied (Step S4; No), the operation mode determination unit 12 determines whether to select the normal receiving mode, based on the average increase amount or the like of the garbage pile height per unit time and the automatic determination logic in FIG. 4(b) and the like (Step S6). When the average increase amount of the garbage pile height per unit time or the like satisfies the condition of the normal receiving mode (Step S6; Yes), the operation

mode determination unit 12 determines the operation mode as the normal receiving mode (Step S7).

[0040]

When the condition of the normal receiving mode is not satisfied (Step S6; No),
 5 the operation mode determination unit 12 determines whether to select the semi-busy mode, based on the average increase amount or the like of the garbage pile height per unit time and the automatic determination logic in FIG. 4(b) and the like (Step S8).

When the average increase amount of the garbage pile height per unit time or the like satisfies the condition of the semi-busy mode (Step S8; Yes), the operation mode

10 determination unit 12 determines the operation mode as the semi-busy mode (Step S9).

When the condition is not satisfied (Step S8; No), the operation mode determination unit 12 determines the operation mode as the busy mode (Step S10). When the garbage pile height in the receiving area exceeds the threshold value Th2, the automatic determination logic in FIG. 5B can be used in the determination in Steps S4, S6, and S8. In a

15 flowchart in FIG. 9, during the automatic switching, the operation mode is switched to any one of the stirring receiving mode, the normal receiving mode, the semi-busy mode, or the busy mode. Meanwhile, the operation mode is not limited to these four, and may be switched to any one of five or more operation modes, or may be switched to any one of three or less operation modes.

20 [0041]

(Advantageous Effects)

As described above, according to the present embodiment, the operation mode of the receiving is automatically switched, based on a relationship of the average increase amount of the garbage pile height with respect to (garbage transport amount - receiving
 25 speed) per unit time. In this manner, for example, when the garbage pile height is

compared with the threshold value and exceeds the threshold value, the switching of the operation mode can be performed earlier than the control for performing the operation to avoid the overflow, and the overflow of the receiving source area of the garbage can be prevented. Furthermore, when the garbage pile height in the receiving source area

5 exceeds the threshold value Th2, for example, even when the average increase amount of the garbage pile height with respect to (garbage transport amount - receiving speed) corresponds to the normal receiving mode, the overflow can be more reliably avoided by adding correction such that selecting the semi-busy mode or the busy mode. In addition, during a period from the completion of the garbage input to the next morning,

10 the average increase amount of the garbage pile height with respect to (garbage transport amount - receiving speed) becomes smallest. Therefore, the receiving is performed in the stirring receiving mode. In this manner, it is possible to achieve both the reduction of the garbage pile height and the improvement in the total evaluation point of the garbage. In the above description, (garbage input amount - receiving speed) per unit

15 time and the average increase amount of the garbage pile height have the linear relationship. Meanwhile, the present embodiment can be applied even when these relationships are relationships represented by a polynomial instead of simple linear relationships. For example, the present embodiment can be applied to a case of a relationship in which an output having a certain degree of relevance to an input is output,

20 such as multiple regression, ridge regression, or a neural network.

[0042]

FIG. 10 is a diagram showing an example of a hardware configuration of the control device. A computer 900 includes a CPU 901, a main storage device 902, an auxiliary storage device 903, an input/output interface 904, and a communication

25 interface 905. The control device 10 described above is mounted on the computer 900.

In addition, each function described above is stored in the auxiliary storage device 903 in a form of a program. The CPU 901 reads the program from the auxiliary storage device 903, deploys the program in the main storage device 902, and executes the above-described processes according to the program. In addition, the CPU 901 secures a storage area in the main storage device 902 according to the program. The CPU 901 secures a storage area for storing data being processed in the auxiliary storage device 903 according to the program.

[0043]

Processing of each functional unit may be performed by recording a program for realizing all or some of the functions of the control device 10 on a computer-readable recording medium, and reading and executing the program recorded on the recording medium in the computer system. Here, it is assumed that the term "computer system" described here includes an OS and hardware such as a peripheral device. In addition, the "computer system" includes a homepage providing environment (or a display environment) when a WWW system is used. The term "computer-readable recording medium" refers to a portable medium, such as a CD, a DVD, or a USB, or a storage device, such as a hard disk drive incorporated in the computer system. In addition, when this program is distributed to the computer 900 via a communication line, the computer 900 receiving the distribution may deploy the program in the main storage device 902, and may perform the above-described processing. In addition, the program may realize some of the above-described functions, and, furthermore, may be capable of realizing the above-described functions in combination with the program previously recorded in the computer system.

[0044]

While preferred embodiments of the invention have been described and

illustrated above, it should be understood that these are exemplary of the invention and are not to be considered as limiting. Additions, omissions, substitutions, and other modifications can be made without departing from the scope of the invention.

Accordingly, the invention is not to be considered as being limited by the foregoing

5 description and is only limited by the scope of the appended claims.

[0045]

<Appendix>

The control device and the method for controlling the crane according to the embodiment are understood as follows, for example.

10 [0046]

(1) According to a first aspect, there is provided a control device. In a case where an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving destination area, and an operation of transporting the garbage from
15 the receiving source area to the receiving destination area is defined as receiving. The control device includes means for determining an operation mode of the receiving, based on an increase amount of a garbage pile height in the receiving source area corresponding to a value obtained by subtracting a transport amount of garbage from the receiving source area to the receiving destination area per unit time from the amount of the garbage
20 input to the receiving source area per unit time, and an automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

25 In this manner, the overflow of the garbage pile height in the receiving source

area can be prevented.

[0047]

(2) According to a second aspect, there is provided a control device. In a case where an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving destination area, and an operation of transporting the garbage from the receiving source area to the receiving destination area is defined as receiving, the control device includes means for determining an operation mode of the receiving, based on the increase amount of the garbage pile height in the receiving source area corresponding to the congestion degree of a garbage collection vehicle which inputs the garbage to the receiving source area, and the automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which the position or the range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

In this manner, the overflow of the garbage pile height in the receiving source area can be prevented.

[0048]

(3) As a control device according to a third aspect, in the control device according to (1) to (2), in the automatic determination logic of the operation mode, as the increase amount of the garbage pile height in the receiving source area increases, the operation mode in which the transport amount of the garbage from the receiving source area to the receiving destination area increases may be associated, and as the increase amount of the garbage pile height in the receiving source area decreases, the operation mode in which a state of the garbage in the receiving destination area is homogenized

may be associated.

In this manner, when the increase amount of the garbage pile height is large, the overflow can be prevented in advance by performing the receiving regarding that the movement to the receiving destination area is more important than the stirring, and when
5 the increase amount of the garbage pile height is small, a state of the garbage can be homogenized to a state suitable for combustion by stirring or scattering the garbage over a wide range.

[0049]

(4) As a control device according to a fourth aspect, in the control device
10 according to (1) to (3), in the automatic determination logic of the operation mode, a case where the garbage pile height in the receiving source area is higher than a predetermined threshold value indicating that the garbage pile height is close to an overflow compared to when the height is not higher than the predetermined threshold value, the operation mode in which the transport amount of the garbage from the receiving source area to the
15 receiving destination area increases may be associated, even if the increase in the garbage pile height in the receiving area is smaller than when the garbage pile height in the receiving area is equal to or lower than the threshold.

In this manner, the overflow of the garbage pile height in the receiving source area can be more reliably prevented.

20 [0050]

(5) According to a fifth aspect, there is provided a method for controlling a garbage crane. In a case where an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving destination area, and an operation of
25 transporting the garbage from the receiving source area to the receiving destination area

is defined as receiving, the method includes determining an operation mode of the receiving, and receiving garbage in the determined operation mode, based on the increase amount of the garbage pile height in the receiving source area corresponding to a value obtained by subtracting a transport amount of garbage from the receiving source area to the receiving destination area per unit time from the amount of the garbage input to the receiving source area per unit time, and an automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

10 [0051]

(6) According to a sixth aspect, there is provided a method for controlling a garbage crane. In a case where an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving destination area, and an operation of transporting the garbage from the receiving source area to the receiving destination area is defined as receiving, the method includes determining an operation mode of the receiving, and receiving garbage in the determined operation mode, based on the increase amount of the garbage pile height in the receiving source area corresponding to the congestion degree of a garbage collection vehicle which inputs the garbage to the receiving source area, and an automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.

[0052]

10: Control device

11: Signal acquisition unit

12: Operation mode determination unit

5 13: Control unit

14: Storage unit

900: Computer

901: CPU

902: Main storage device

10 903: Auxiliary storage device

904: Input/output interface

905: Communication interface

What is claimed is:

1. A control device comprising:

in a case where an area to which garbage is input in a garbage pit is defined as a
5 receiving source area, a destination to which the garbage is transported from the
receiving source area is defined as a receiving destination area, and an operation of
transporting the garbage from the receiving source area to the receiving destination area
is defined as receiving,

means for determining an operation mode of the receiving, based on an increase
10 amount of a garbage pile height in the receiving source area corresponding to a value
obtained by subtracting a transport amount of the garbage from the receiving source area
to the receiving destination area per unit time from the amount of the garbage input to the
receiving source area per unit time, and an automatic determination logic of the operation
mode in which the increase amount of the garbage pile height in the receiving source area
15 is associated with the operation mode in which a position or a range of the receiving
destination area to which the garbage transported in the receiving is dropped is defined.

2. A control device comprising:

in a case where an area to which garbage is input in a garbage pit is defined as a
20 receiving source area, a destination to which the garbage is transported from the
receiving source area is defined as a receiving destination area, and an operation of
transporting the garbage from the receiving source area to the receiving destination area
is defined as receiving,

means for determining an operation mode of the receiving, based on an increase
25 amount of a garbage pile height in the receiving source area corresponding to a

congestion degree of a garbage collection vehicle which inputs the garbage to the receiving source area, and an automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which a position or a range of the receiving
5 destination area to which the garbage transported in the receiving is dropped is defined.

3. The control device according to Claim 1 or 2,

wherein in the automatic determination logic of the operation mode, as the increase amount of the garbage pile height in the receiving source area increases, the
10 operation mode in which the transport amount of the garbage from the receiving source area to the receiving destination area increases is associated, and as the increase amount of the garbage pile height in the receiving source area decreases, the operation mode in which a state of the garbage in the receiving destination area is homogenized is associated.

15

4. The control device according to Claim 1 or 2,

wherein in the automatic determination logic of the operation mode, a case where the garbage pile height in the receiving source area is higher than a predetermined threshold value indicating that the garbage pile height is close to an overflow compared
20 to when the height is not higher than the predetermined threshold value, the operation mode in which the transport amount of the garbage from the receiving source area to the receiving destination area increases may be associated, even if the increase in the garbage pile height in the receiving area is smaller than when the garbage pile height in the receiving area is equal to or lower than the threshold.

25

5. A method for controlling a garbage crane, the method comprising:

in a case where an area to which garbage is input in a garbage pit is defined as a receiving source area, a destination to which the garbage is transported from the receiving source area is defined as a receiving destination area, and an operation of transporting the garbage from the receiving source area to the receiving destination area is defined as receiving,

determining an operation mode of the receiving, and receiving garbage in the determined operation mode, based on an increase amount of a garbage pile height in the receiving source area corresponding to a value obtained by subtracting a transport amount of garbage from the receiving source area to the receiving destination area per unit time from the amount of the garbage input to the receiving source area per unit time, and an automatic determination logic of the operation mode in which the increase amount of the garbage pile height in the receiving source area is associated with the operation mode in which a position or a range of the receiving destination area to which the garbage transported in the receiving is dropped is defined.