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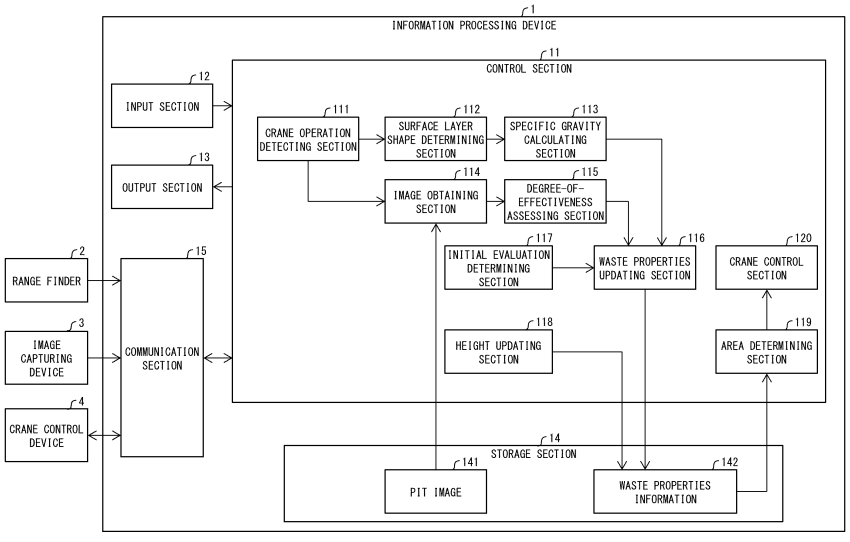
(54) INFORMATION PROCESSING DEVICE, INFORMATION PROCESSING METHOD, AND INFORMATION PROCESSING PROGRAM

(57) To accurately evaluate waste properties, an information processing device (1) includes: a degree-of-effectiveness assessing section (115) configured to, when waste has been subjected to mixing in the waste pit, assess the degree of effectiveness of the mixing from an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and a waste properties updating section (116) configured to update an evaluation of waste properties of the waste having been subjected to mixing, and, in performing the update, adjust the degree of change of the evaluation of the waste properties in accordance with the degree of effectiveness.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an information processing device and the like, for evaluating waste properties of waste deposited in a waste pit.

Background Art

[0002] In a waste incineration plant, carried-in waste is once stored in a waste pit, and the stored waste is successively fed into an incinerator for incineration. The carried-in waste contains waste which is easy to burn and waste which is rich in water and is hard to burn. Therefore, for stable waste incineration, it is important to mix the waste in the waste pit to homogenize the waste.

[0003] For this reason, a technique for realizing mixing for homogenization of waste has been developed conventionally. For example, Patent Literature 1 listed below discloses performing a computation to determine the number of times of mixing of waste and calculating an evaluation value that indicates the degree of mixing of waste based on the number of times of mixing.

Citation List

[Patent Literature]

[0004] [Patent Literature 1]
Japanese Patent Application Publication, *Tokukai*, No. 2010-275064 (Publication Date: December 9, 2010)

Summary of Invention

Technical Problem

[0005] Unfortunately, the number of times of mixing is not always accurately reflected in the waste properties. For example, an important purpose of mixing is to break garbage bags and spread waste in the garbage bags apart. However, even when the same single mixing is carried out, most of garbage bags may break, or many garbage bags may remain the same as before the mixing without being broken. In the former case, the waste properties are greatly improved, and in the latter case, the waste properties are not much improved. Unfortunately, in the technique of Patent Literature 1, the evaluation values are the same in both of the cases.

[0006] It is an object of an aspect of the present invention to realize an information processing device and the like capable of accurately evaluating the waste properties.

Solution to Problem

[0007] In order to solve the above problem, an information processing device in accordance with an aspect of the present invention is an information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the information processing device including: a degree-of-effectiveness assessing section configured to, when waste has been subjected to mixing in the waste pit, assess a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and an updating section configured to update an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and configured to, in performing the update, adjust a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness.

[0008] Further, in order to solve the above problem, a method for processing information in accordance with an aspect of the present invention is a method for processing information by use of an information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the method including: a degree-of-effectiveness assessing step of, when waste has been subjected to mixing in the waste pit, assessing a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and an updating step of updating an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and, in performing the update, adjusting a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness.

Advantageous Effects of Invention

[0009] The aspect of the present invention brings about the effect of accurately evaluating the waste properties.

Brief Description of Drawings

[0010]

Fig. 1 is a block diagram illustrating an example of main components of an information processing device in accordance with Embodiment 1 of the present invention.
Fig. 2 is a diagram illustrating an outline of an update of waste properties information.
Fig. 3 is a view illustrating an outline of a method of calculating a volume of waste.
Fig. 4 is a view illustrating a captured image obtained by capturing an image of a waste layer surface and an image obtained as a result of extracting edges from the captured image.
Fig. 5 is a flowchart illustrating an example of a process for updating waste properties at the mixing operation.

Description of Embodiments

[Embodiment 1]

[0011] The following description will discuss an information processing device 1 in accordance with an embodiment of the present invention with reference to Figs. 1 to 5. The information processing device 1 has a function of evaluating waste properties of waste deposited in an internal space of a waste pit, which is a waste storage facility in a waste incineration plant. The waste properties are generally evaluated based on factors such as water content of waste, ash content of waste, combustible content of waste, and low calorific value of waste. Of these factors, the low calorific value and the water content (which may account for about 60% of the weight of waste) in particular have a significant impact on the combustibility of waste. Thus, the waste properties can be used as an index for evaluating the combustibility of waste. A method of evaluating the waste properties in Embodiment 1 will be described later. The waste incineration plant includes, in addition to the waste pit and the incinerator, other facilities such as a crane that transfers waste in the waste pit. The waste incineration plant only needs to include at least the waste pit, the crane, and the incinerator, and any other facilities to be included in the waste incineration plant are selected as necessary.

[Device configuration]

[0012] The following description will discuss a configuration of an information processing device in accordance with Embodiment 1 with reference to Fig. 1. Fig. 1 is a block diagram illustrating an example of main components of the information processing device 1. Fig. 1 also illustrates, as devices associated with the information processing device 1, a range finder 2, an image capturing device 3, and a crane control device 4.

[0013] The information processing device 1 is capable of communicating with the range finder 2, the image capturing device 3, and the crane control device 4. The communication with these devices may be wired communication or may be wireless communication. The information processing device 1 may be, for example, a personal computer or the like.

[0014] The range finder 2 measures a distance to a surface of a waste layer at each point in the waste pit and then outputs a measurement result to the information processing device 1. The range finder 2 only needs to determine a surface shape of the waste layer from the measurement result. The range finder 2 may be, for example, a laser range finder. Although only one range finder 2 is illustrated in Fig. 1, a plurality of range finders 2 may be used.

[0015] The image capturing device 3 captures an image of the inside of the waste pit and then outputs the captured image to the information processing device 1. The image capturing device 3 may be a device that captures a moving image or may be a device that captures a still image. As in the case of the range finder 2, a plurality of image capturing devices 3 may be provided.

[0016] The crane control device 4 operates the crane by transmitting a control signal to the crane. In addition, the crane control device 4 outputs, to the information processing device 1, an operation signal indicating the status of operation control over the crane. For example, to cause the crane to carry out a waste mixing operation, the crane control device 4 outputs an operation signal indicating a start of the mixing operation, at the start of the mixing operation. Further, when the crane control device 4 has caused a bucket to carry out a waste grabbing operation in the mixing operation, the crane control device 4 outputs an operation signal indicating (i) the fact that the waste grabbing operation has been carried out and (ii) a location at which waste has been grabbed (hereinafter also referred to as "waste grabbing location"). When the crane control device 4 has caused the bucket to carry out a waste release operation in the mixing operation, the crane control device 4 outputs an operation signal indicating (i) the fact that the waste release operation has been

carried out and (ii) a location at which waste has been released (hereinafter also referred to as "waste release location").

[0017] Note that the mixing operation is an operation such that the bucket of the crane grabs and lifts waste in the waste pit and then releases the grabbed and lifted waste in the waste pit. Other typical operations of the crane include a restacking operation and an introduction operation. Like the mixing operation, the restacking operation is an operation such that the bucket of the crane grabs and lifts waste in the waste pit and then releases the grabbed and lifted waste in the waste pit. However, the restacking operation differs from the mixing operation in that a location at which waste is grabbed and lifted lies in a waste brought-in area (an area where waste unloaded from a garbage truck is first deposited), and a location at which waste is released is outside the above-described waste brought-in area. Further, the introduction operation is an operation such that the bucket of the crane grabs and lifts waste in the waste pit and then introduces the grabbed and lifted waste into a waste hopper. The waste having been introduced into the waste hopper is fed to the incinerator for incineration.

[0018] The information processing device 1 includes: a control section 11 that centrally controls each section of the information processing device 1; an input section 12 that accepts an entry of data and the like to the information processing device 1; an output section 13 that outputs data; and a storage section 14 that stores various kinds of data used by the information processing device 1. The information processing device 1 further includes a communication section 15 for allowing the information processing device 1 to communicate with other device. Fig. 1 illustrates an example case in which the information processing device 1 communicates with the range finder 2, the image capturing device 3, and the crane control device 4 via one communication section 15. Alternatively, the information processing device 1 may be configured to communicate with different devices via different communication sections. The input section 12, the output section 13, the storage section 14, and the communication section 15 may be provided outside the information processing device 1.

[0019] Further, the control section 11 includes a crane operation detecting section 111, a surface layer shape determining section 112, a specific gravity calculating section 113, an image obtaining section 114, a degree-of-effectiveness assessing section 115, a waste properties updating section 116, an initial evaluation determining section 117, a height updating section 118, an area determining section 119, and a crane control section 120. The storage section 14 stores a pit image 141 and waste properties information 142.

[0020] The pit image 141 is a captured image obtained by capturing an image of waste in the waste pit. As described above, since the image capturing device 3 captures an image of waste in the waste pit, the information processing device 1 obtains the captured image from the image capturing device 3 through communication via the communication section 15 and then stores the obtained image in the storage section 14. The stored image is the pit image 141. The pit image 141 only needs to be an image of at least a surface of waste in the waste pit.

[0021] The waste properties information 142 is information indicative of waste properties evaluated by the information processing device 1 for each of individual unit areas into which the internal space of the waste pit is divided. The unit areas may be defined in any manner. The description in Embodiment 1 will discuss an example case in which rectangular parallelepiped-shaped unit areas each having a predetermined width, depth, and height are defined by dividing a substantially rectangular parallelepiped-shaped internal space of the waste pit at predetermined intervals in a width direction, in a depth direction, and in a height direction, respectively. Further, the waste properties information 142 includes, for each unit area, information indicative of a height of waste at a location of the unit area. The waste properties information 142 will be described later with reference to Fig. 2.

[0022] The crane operation detecting section 111 detects that the crane starts a predetermined operation in the waste pit and detects that the crane has carried out the predetermined operation in the waste pit. Specifically, the crane operation detecting section 111 determines that the mixing operation or the restacking operation is started, based on the operation signal received from the crane control device 4. Further, the crane operation detecting section 111 detects, based on the operation signals received from the crane control device 4, that the waste grabbing operation has been carried out by the crane, that the waste release operation has been carried out by the crane, and the locations at which these operations have been carried out.

[0023] The surface layer shape determining section 112 determines the surface shape of a waste layer deposited in the waste pit. Specifically, the surface layer shape determining section 112 determines the surface shape of the waste layer at a certain location before the waste grabbing operation is carried out by the crane and the surface shape of the waste layer at that location after the waste grabbing operation has been carried out by the crane. The description in Embodiment 1 will discuss an example case where the surface layer shape determining section 112 determines the surface shape of the waste layer by using the measurement result obtained by the range finder 2. Note that the method of determining the surface shape of the waste layer is not limited to the method in such an example case. Alternatively, the surface shape of the waste layer can be determined by, for example, analyzing a captured image obtained by capturing an image of the surface of the waste layer with use of a stereo camera.

[0024] The specific gravity calculating section 113, when waste has been subjected to mixing in the waste pit, calculates a specific gravity of the waste having been subjected to mixing. Specifically, the specific gravity calculating section 113 calculates a volume of the waste having been subjected to the mixing from the surface shape of the waste layer before

being subjected to the mixing and the surface shape of the waste layer after having been subjected to the mixing, the surface shapes having been determined by the surface layer shape determining section 112. Note that a method of calculating the volume will be described later with reference to Fig. 3. Then, the specific gravity calculating section 113 calculates a density of the waste having been subjected to the mixing from the calculated volume and the weight of the waste having been subjected to the mixing, and then calculates the specific gravity of the waste having been subjected to the mixing from the calculated density. Generally, waste having a high specific gravity is hard to burn, and waste having a low specific gravity is easy to burn. Thus, the specific gravity is an index for evaluating the waste properties. A method of obtaining the weight of waste is not limited to any specific method and may be, for example, a method such that a weight sensor is provided in the crane, the weight sensor measures the weights of the waste-grabbing bucket before and after the waste grabbing operation, and a difference between the measured weights of the bucket is calculated to serve as the weight of the waste.

[0025] The image obtaining section 114 obtains an image to be used for assessment of the degree of effectiveness of mixing and then outputs the obtained image to the degree-of-effectiveness assessing section 115. Specifically, at the start of the waste mixing operation, the image obtaining section 114 obtains a pit image 141 which includes an image of the waste grabbing location before being subjected to the waste grabbing operation, and then cuts out the image of the waste grabbing location from the obtained image. Similarly, the image obtaining section 114 obtains a pit image 141 which includes an image of the waste release location after having been subjected to the waste release operation, and then cuts out the image of the waste release location from the obtained image.

[0026] When waste has been subjected to mixing in the waste pit, the degree-of-effectiveness assessing section 115 assesses the degree of effectiveness of the mixing from an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing. The degree of effectiveness of mixing is an index that indicates what degree of effectiveness in enhancing the suitability of waste having been subjected to mixing as a fuel has been achieved by that mixing. Specifically, the degree-of-effectiveness assessing section 115 analyzes the image, cut out by the image obtaining section 114, of the waste grabbing location to evaluate the waste properties of the waste before being subjected to the mixing. Similarly, the degree-of-effectiveness assessing section 115 analyzes the image, cut out by the image obtaining section 114, of the waste release location to evaluate the waste properties of the waste after having been subjected to the mixing. Then, the degree-of-effectiveness assessing section 115 assesses the degree of effectiveness of mixing from a difference between these evaluation results. Note that a method of evaluating the waste properties and a method of assessing the degree of effectiveness will be described later with reference to Fig. 4.

[0027] Every time waste has been subjected to mixing in the waste pit, the waste properties updating section 116 updates the waste properties of the waste in an area into which the waste having been subjected to mixing was dropped. Further, the waste properties updating section 116, in performing the update, adjusts the degree of change of evaluation of the waste properties in accordance with the degree of effectiveness having been assessed by the degree-of-effectiveness assessing section 115. Further, the waste properties updating section 116, in performing the update, adjusts the degree of change of evaluation of the waste properties in accordance with the specific gravity having been calculated by the specific gravity calculating section 113. These adjustments will be described later with reference to Fig. 2.

[0028] The initial evaluation determining section 117 determines an initial evaluation of waste properties of waste brought in the waste pit. More specifically, the initial evaluation determining section 117 determines an initial evaluation of the waste properties according to the following factors: a day of the week on which waste is brought in, weather of a region from which waste brought in has been collected, a type of waste to be collected by a vehicle for bringing in waste, and a region from which the brought-in waste has been collected. Then, the initial evaluation determining section 117 notifies the waste properties updating section 116 of the determined initial evaluation, and then, the waste properties updating section 116 updates the waste properties information 142.

[0029] The day of the week on which waste is brought in is a useful factor for determining the initial evaluation of the waste properties in a case where there is an imbalance in waste properties by day of the week. The initial evaluation determining section 117 determines the initial evaluation of the waste properties such that the initial evaluation is high on a day of the week on which the waste properties tend to be high, whereas the initial evaluation is low on a day of the week on which the waste properties tend to be low. Note that a relationship between a day of the week and the waste properties may be determined in advance.

[0030] The weather of a region from which waste brought in has been collected have an influence on dryness of waste and is thus a useful factor for determining the initial evaluation of the waste properties. The initial evaluation determining section 117 determines the initial evaluation of the waste properties such that the initial evaluation is high in a case where weather of a region from which waste has been collected is sunny weather or cloudy weather, whereas the initial evaluation is low in a case where the weather is rainy weather, snowy weather, or the like weather. Note that information on the weather may be entered by a user of the information processing device 1 through the input section 12 or may be obtained by the information processing device 1 through communication performed via the communication section 15.

[0031] The type of waste to be collected by a vehicle for bringing in waste is also a useful factor for determining the initial evaluation of the waste properties, since it is natural that the combustibility of waste varies depending on the type

of waste. The initial evaluation determining section 117 determines the initial evaluation of the waste properties such that the initial evaluation of waste brought in by a bring-in vehicle for collecting waste of a waste type which is easy to burn is high, whereas the initial evaluation of waste brought in by a bring-in vehicle for collecting waste of a waste type which is hard to burn is low. Note that the bring-in vehicle can be identified by, for example, analyzing an image which is obtained by capturing an image of the bring-in vehicle. Note also that a relationship between the bring-in vehicle and the waste type may be determined in advance.

[0032] The region from which the brought-in waste has been collected is a useful factor for determining the initial evaluation of the waste properties in a case where there is an imbalance in waste properties by region. The initial evaluation determining section 117 determines the initial evaluation of the waste properties such that the initial evaluation of waste collected in a region in which the waste properties tend to be high is high, whereas the initial evaluation of waste collected in a region in which the waste properties tend to be low is low. In a case where the region from which brought-in waste is collected is determined for each bring-in vehicle, the region from which brought-in waste is collected can also be identified by identifying the bring-in vehicle as described above. Note also that a relationship between the region and the waste properties may be determined in advance.

[0033] A method of evaluating each of the factors and how to reflect an evaluation of each of the factors in the initial evaluation of the waste properties may be determined as appropriate. For example, an initial evaluation value of the waste properties may be calculated by performing a computation such that evaluation values for the individual factors are calculated according to predetermined evaluation criteria, the evaluation values are subjected to the assignment of weights, and then the weighted evaluation values are added to each other. In addition, the initial evaluation of the waste properties may be determined based on at least one of the above factors rather than all of the above factors.

[0034] The height updating section 118 updates a waste height included in the waste properties information 142 such that the waste height included in the waste properties information 142 matches the measurement result obtained by the range finder 2. Specifically, the height updating section 118 compares waste height distribution included in the waste properties information 142 with waste height distribution determined from the measurement result obtained by the range finder 2, and then updates the height included in the waste properties information 142 to the height determined from the measurement result obtained by the range finder 2, for a part with difference in height. The height update by the height updating section 118 may be carried out (i) at any time point (e.g., at predetermined time intervals), may be carried out (ii) at a time point when the crane operation detecting section 111 detects the waste grabbing operation or when the crane operation detecting section 111 detects the waste release operation, or may be carried out at both of these time points (i) and (ii).

[0035] The area determining section 119, in periodically introducing waste in the waste pit into the waste hoper so that the introduced waste is fed into the incinerator, determines a target area from which waste in the waste pit is to be introduced into the waste hopper. At this time, the area determining section 119 refers to the waste properties information 142 to determine a target unit area to be subjected to the introduction such that a difference between an evaluation of waste properties of a target area which was determined in the past to be subjected to the introduction and an evaluation of waste properties of a target area to be newly determined to be subjected to the introduction falls within a predetermined range.

[0036] Further, in a case where two or more unit areas have waste properties that satisfy a preset criterion for the introduction into the waste hopper, the area determining section 119 determines a target unit area to be subjected to the introduction in the following manner. That is, the area determining section 119 determines a unit area, of the two or more unit areas having waste properties that satisfy the preset criterion, corresponding to a location into which waste having a relatively low specific gravity as calculated by the specific gravity calculating section 113 was dropped, to be the target unit area to be subjected to the introduction. Note that details of the method of determining the target unit area to be subjected to the introduction will be described later.

[0037] The crane control section 120 controls an operation of the crane. Specifically, the crane control section 120 controls the operation of the crane by notifying the crane control device 4 of details of the operation of the crane. For example, the crane control section 120 notifies the crane control device 4 of the location of the unit area determined by the area determining section 119 as the waste grabbing location at the introduction operation. In response to the notification, the crane control device 4 causes the crane to carry out the waste grabbing operation at that location and introduce the waste grabbed by the waste grabbing operation into the waste hopper.

[Update of waste properties information]

[0038] The following description will discuss an update of the waste properties information 142 with reference to Fig. 2. Fig. 2 is a diagram illustrating an outline of the update of the waste properties information 142. Note that Fig. 2 illustrates, out of pieces of unit area data contained in the waste properties information 142, heights and waste properties in 100 unit areas corresponding to surfaces of waste layers. That is, in an example in Fig. 2, unit areas with a rectangular shape when viewed from above are defined by dividing an internal space of the waste pit into 10 equal parts in a

transverse direction of the crane, and dividing the same space into 10 equal parts in the traveling direction of the crane. Further, although not illustrated in Fig. 2, the internal space of the waste pit is divided by a plane parallel to a bottom surface of the waste pit in increments of a predetermined height from the bottom of the waste pit. Each of the unit areas has the predetermined height. The width, depth, and height of each unit area may be set as appropriate. For example, the width, depth, and height of each unit area may be set on the basis of (i) the width and height of an area having a height which is changed by one grab by the crane and (ii) the waste height which is changed by one grab. For example, in a case where the waste height in approximately one square meter area is decreased by approximately 0.5 m by one grab of the crane, the width, depth, and height of each unit area may be 1 m, 1 m, and 0.5 m, respectively.

[0039] The waste height in the waste properties information 142 is updated by the height updating section 118 based on the measurement result obtained by the range finder 2. For example, of the unit areas in the waste properties information 142 illustrated in Fig. 2, the unit area at the upper left corner has a height of 10. In a case where the measurement result obtained by the range finder 2 indicates that the height of that unit area is 11, the height updating section 118 calculates a difference between these heights to be +1 and then performs an update by adding the difference to the height before the update. That is, the height of that unit area is updated to 11.

[0040] In a case where an increased height has changed a state of a certain unit area from a state in which waste is absent previously to a state in which waste is present, i.e. in a case where waste has been newly brought in inside the waste pit and in a case where waste has been mixed or restacked, the waste properties updating section 116 updates the waste properties of that unit area. In the case where waste has been newly brought in, the initial evaluation determining section 117 evaluates the waste properties of such new waste. Thus, the waste properties updating section 116 updates (properly speaking, newly sets) the waste properties of waste in that unit area based on a result of the evaluation.

[0041] Meanwhile, in the case where waste has been mixed, the waste properties updating section 116 updates the waste properties of waste in that unit area in a manner as described below. Note that the following description will discuss an update performed when the mixing has been carried out, but the same update is also performed when the restacking has been carried out. Factors taken into account by the waste properties updating section 116 to perform the update when the mixing has been carried out are: mixing information indicative of how mixing of waste has been carried out; the specific gravity of waste calculated by the specific gravity calculating section 113; and the degree of effectiveness of mixing assessed based on waste appearance by the degree-of-effectiveness assessing section 115. Specifically, the mixing information, which is information indicative of waste grabbing location and waste release location detected by the crane operation detecting section 111, may be, for example, a coordinate value that serves as a basis for identifying the waste grabbing location and the waste release location. For example, the mixing information may be, in a coordinate system set such that coordinate axes are the traveling direction of the crane and the transverse direction of the crane, a coordinate value of the center of the waste release location or the waste grabbing location.

[0042] To perform the update, the waste properties updating section 116 first determines, from the mixing information, a unit area corresponding to the waste grabbing location and a unit area corresponding to the waste release location. In a case where the mixing information is a coordinate value, a unit area is determined on the basis of the coordinate value. In a case where the waste properties updating section 116 determines the unit area corresponding to the waste grabbing location, the waste properties updating section 116 determines the unit area according to the size of an area covered by one waste grab. Further, in a case where the waste properties updating section 116 determines the unit area corresponding to the waste release location, the waste properties updating section 116 determines the unit area according to the size of an area to which dropped waste spreads.

[0043] Next, the waste properties updating section 116 refers to the waste properties information 142 to determine waste properties of the unit area corresponding to the waste grabbing location. Then, The waste properties updating section 116 calculates the degree of change of the waste properties by the equation below. In the following equation, "a" to "c" are coefficients for weighting.

$$\text{(Degree of change of waste properties)} = a \times \text{(evaluation value of waste properties based on increase in number of times of mixing)} + b \times \text{(evaluation value of waste properties based on specific gravity)} + c \times \text{(evaluation value of waste properties based on degree of effectiveness)}$$

[0044] The coefficients "a" to "c" may be set as appropriate depending on which of the evaluation values emphasis is

to be placed on. Further, each of the above evaluation values only needs to be a value correlated with the waste properties, and a method of calculating each of the above evaluation values is not particularly limited. For example, the evaluation value of waste properties based on increase in number of times of mixing may be + 1 for every increase of one mixing. Further, the evaluation value of waste properties based on specific gravity may be a value which is determined depending on which of a plurality of predetermined ranges a value of the specific gravity falls within. For example, the specific gravity may be ranked in the following three levels: "high", "medium", and "low". If the specific gravity is ranked to be "high", which indicates that waste is expected to be difficult to burn, the evaluation value may be set to a negative value (e.g.,-0.5). If the specific gravity is ranked to be "low", which indicates that waste is expected to be easy to burn, the evaluation value may be set to a positive value (e.g., +0.5). Then, the evaluation value corresponding to the specific gravity ranked to be "medium" may be set to a value (e.g., 0) intermediate between the positive value and the negative value. Further, the evaluation index based on the degree of effectiveness may be set as follows. That is, for example, the degree of effectiveness may be ranked in the following two levels: "high" and "low". If the degree of effectiveness is ranked to be "high", the evaluation index may be +0.5. If the degree of effectiveness is ranked to be "low", the evaluation index may be 0.

[0045] The waste properties updating section 116 adds the degree of change of the waste properties calculated as described above to a value of the waste properties of the unit area corresponding to the waste grabbing location, thereby calculating the value of the waste properties of waste having been subjected to mixing. Then, the waste properties updating section 116 determines, in the waste release location, a unit area immediately above a unit area which had been a surface layer until immediately before the waste release operation was carried out, and then sets the waste properties of the determined unit area as the calculated value. Note that the height of this unit area is determined by the height updating section 118.

[0046] Further, the waste properties updating section 116 updates data for the unit area corresponding to the waste grabbing location if necessary. For example, in a case where all waste in the unit area corresponding to the waste grabbing location has been grabbed and removed by the waste grabbing operation, the waste properties updating section 116 deletes data on the waste properties and height of that unit area. As a result, the unit area immediately below the unit area for which data has been deleted becomes a unit area corresponding to the surface layer of waste.

[Method of determining waste to be introduced into waste hopper]

[0047] The area determining section 119 refers to the waste properties information 142 as illustrated in Fig. 2 to determine which of the unit areas is to be the waste grabbing location in an introduction process of introducing waste into the waste hopper. At this time, the area determining section 119 determines a target unit area to be subjected to the introduction such that a difference between an evaluation of waste properties of a target area which was determined in the past to be subjected to the introduction and an evaluation of waste properties of a target area to be newly determined to be subjected to the introduction falls within a predetermined range. For example, assume that the past introduction is a previous introduction, and the above-described predetermined range is a range of ± 1. In such a case, if the waste properties of the waste grabbing location which was determined to be subjected to the previous introduction process is 7, the area determining section 119 determines a unit area with the waste properties of 6 to 8 to be subjected to the introduction. As a matter of course, the predetermined range may be wider or narrower, and the past introduction to be considered may be a plurality of introductions. In a case where the plurality of introductions are taken into account, the waste grabbing location may be determined on the basis of an average value of waste properties of two or more most recently determined waste grabbing locations.

[0048] Note that even though a difference from the evaluation of the waste properties of the area which was determined in the past to be subjected to the introduction was small, introduction of waste having excessively low waste properties is not preferable. Therefore, it is preferable that a lower limit value of the waste properties is set so that the area determining section 119 does not set a unit area with waste properties falling below the lower limit value to be the waste grabbing location in the introduction process. In the vicinity of a bringing-in entrance where unloaded waste is brought in, waste having low waste properties is often present. In some of waste pits, waste that is not suitable for burning is separated from other waste and is collected in a predetermined area inside the waste pit. It is preferable that the area determining section 119 does not set such areas to be the waste grabbing location in the introduction process.

[0049] Further, the area determining section 119 may determine a unit area corresponding to the waste grabbing location on the condition that the unit area satisfies a certain evaluation value of waste properties based on specific gravity. That is, the area determining section 119 may determine a unit area corresponding to a location into which waste having a relatively low specific gravity as calculated by the specific gravity calculating section 113 was dropped, to be the target unit area to be subjected to the introduction. Further, the area determining section 119 may determine a unit area corresponding to the waste grabbing location in the introduction process on the condition that the unit area satisfies at least one of the following factors: height (a higher priority is given to a unit area having a greater height); the number of times of mixing (a higher priority is given to a unit area having been subjected to mixing a larger number of times);

and a distance from a position at which the bucket of the crane is currently present (a higher priority is given to a unit area which is closer to the position). In addition, the area determining section 119 may determine a unit area corresponding to the waste grabbing location in the introduction process on the condition that the unit area satisfies, for example, a certain evaluation value of waste properties based on the degree of effectiveness (a higher priority is given to a unit area having a higher degree of effectiveness). Further, the waste properties information 142 may contain, for each of the unit areas, information indicative of a waste storage time and/or information indicative of a waste type. In such a case, a unit area corresponding to the waste grabbing location may be determined based on these pieces of information. Both waste stored for a short period of time and waste stored for an excessively long period of time are hard to burn. Therefore, it is preferable to find out in advance what range of the waste storage time makes waste easy to burn, and then determine a unit area corresponding to that range of the waste storage time to be the waste grabbing location.

[0050] Note that the unit area having been determined by the area determining section 119 to be the waste grabbing location may be presented to the user. The determined unit area may be presented to the user by any method. For example, in a case where the output section 13 serves as a display device for outputting an image, the determined unit area corresponding to the waste grabbing location may be presented to the user by causing the output section 13 to display and output the determined unit area. Then, in such a case, the crane control section 120 may be configured to cause the waste grabbing operation to be carried out on the condition that an entry operation for causing the waste grabbing operation to be carried out in that unit area corresponding to the waste grabbing location has been accepted via the input section 12.

[0051] Further, the area determining section 119 may determine unit areas corresponding to the waste grabbing location and the waste release location in the mixing and the restacking. In the mixing and the restacking, the area determining section 119 preferably determines unit areas corresponding to the waste grabbing location and the waste release location so that a unit area in which waste suitable for the introduction is present is maintained at all times. Further, in a case where the waste storage time is known, the area determining section 119 may determine unit areas corresponding to the waste grabbing location and the waste release location so that waste in the unit areas has waste properties suitable for the introduction after a lapse of an appropriate length of storage time. For example, the area determining section 119 may determine unit areas corresponding to the waste grabbing location and the waste release location so that the waste properties of waste will be evaluated to be 7 to 9 in two to three days after the waste was brought in. Further, in a case where the waste type is known, the area determining section 119 may determine unit areas corresponding to the waste grabbing location and the waste release location so that imbalances in waste type are not caused across the unit areas.

[Calculation of volume of waste]

[0052] The following description will discuss a method of calculating a volume of waste by the specific gravity calculating section 113 with reference to Fig. 3. Fig. 3 is a view illustrating an outline of the method of calculating the volume of waste. (a) of Fig. 3 illustrates a pit image obtained by capturing an image of a waste layer surface before the waste grabbing operation is carried out, and (b) of Fig. 3 is a pit image obtained by capturing an image of a waste layer surface after the waste grabbing operation has been carried out. Note that, in these pit images, an area surrounded by a circle is the waste grabbing location.

[0053] Then, (c) of Fig. 3 illustrates an image that indicates a difference between a height distribution of the waste layer surface the image of which was captured as the pit image illustrated in (a) of Fig. 3 and a height distribution of the waste layer surface the image of which was captured as the pit image illustrated in (b) of Fig. 3. In this image, areas in which the difference in height is 0 is indicated by black, and areas in which the difference in height is larger is indicated by a color closer to white. That is, it can be seen from this image that the height of waste greatly changes in the waste grabbing location, while the height of waste does not change in other areas.

[0054] In (d) of Fig. 3, the height distribution of waste before and after the waste grabbing operation is shown in three-dimensional coordinate space. It can be seen from the graph in (d) of Fig. 3 that waste which had been heaped like a mountain before the waste grabbing operation was removed by the waste grabbing operation and that a depression is left in the waste grabbing location after the waste grabbing operation. The specific gravity calculating section 113 calculates the volume of grabbed waste from a difference between the height distribution of waste before the waste grabbing operation and the height distribution of waste after waste grabbing operation, both of which are shown in (d) of Fig. 3.

[Evaluation of waste properties by analysis of pit image and assessment of the degree of effectiveness]

[0055] The following description will discuss a method of evaluating the waste properties and assessing the degree of effectiveness by the degree-of-effectiveness assessing section 115 with reference to Fig. 4. Fig. 4 is a view illustrating a captured image obtained by capturing an image of a waste layer surface and an image obtained as a result of extracting edges from the captured image. In assessing the degree of effectiveness, the degree-of-effectiveness assessing section

115 evaluates, from the captured image of the waste layer surface, the waste properties of waste the image of which is included in the captured image.

[0056] Specifically, the degree-of-effectiveness assessing section 115, by analyzing the above image, generates, as information indicative of the waste properties, degree-of-complexity information indicative of the degree of complexity of the shape of the waste layer surface. Waste is enclosed in the garbage bags at the time of being brought into the waste pit. Then, mixing breaks the garbage bags and spreads the waste in the garbage bags apart. That is, since effective mixing results in an increase in complexity of outer appearance of waste, the degree-of-complexity information can be used as an index for evaluating the waste properties.

[0057] In generating the degree-of-complexity information, the degree-of-effectiveness assessing section 115 extracts edges of the image, i.e. an outline representing an outside shape of the captured image of waste. (b) of Fig. 4 illustrates an example of extraction of edge. Then, the degree-of-effectiveness assessing section 115 calculates a fractal dimension of the outline as the degree-of-complexity information. The fractal dimension can be calculated by using, for example, the box count method (box counting method), the modified pixel dilation method, or the like method. The degree-of-complexity information may be any information indicative of the degree of complexity of the shape of the waste layer surface, and any index other than the fractal dimension may be used as the degree-of-complexity information.

[0058] The degree-of-effectiveness assessing section 115 calculates the degree-of-complexity information in the manner as described above for each of the image of the waste before being subjected to mixing and the image of the waste after having been subjected to mixing. Then, the degree-of-effectiveness assessing section 115 evaluates a difference between the calculated pieces of degree-of-complexity information based on a predetermined evaluation criterion to assess the degree of effectiveness. The evaluation criterion is not particularly limited. For example, if a value of the difference is equal to or larger than a threshold value, the degree of effectiveness may be assessed to be "high", and if the value of the difference is smaller than the threshold value, the degree of effectiveness may be assessed to be "low".

[0059] Note that the degree-of-effectiveness assessing section 115 may evaluate the waste properties based on color distribution of a captured image obtained by capturing an image of the waste layer surface. This is for the following reason. That is, since the waste enclosed in the garbage bags at the time of being brought into the waste pit is spread apart due to breakage of the garbage bags by mixing as described above, color distribution of the waste is changed by the mixing, and the degree of the change varies depending on whether the mixing was an effective mixing.

[0060] Specifically, the number of pixel regions in which pixels of the same color (which may be pixels of a similar color) are gathered (mainly pixel regions where the garbage bags are shown) increases after the mixing. After the mixing, an area of each pixel region decreases. Then, the degree-of-effectiveness assessing section 115 may calculate an evaluation value based on the color distribution in a manner as described below.

[0061] First, the degree-of-effectiveness assessing section 115 determines the distribution of a color component corresponding to the garbage bags in a capture image obtained by capturing an image of the waste layer surface. Subsequently, the degree-of-effectiveness assessing section 115 extracts, based on the determined distribution, pixel regions in which pixels of the similar color are gathered in the captured image, and calculates the number of the extracted pixel regions and the areas thereof. Then, the degree-of-effectiveness assessing section 115 calculates, from the calculated number and areas, an evaluation value indicating the degree of effectiveness of mixing. This evaluation value may be any value that is larger as the number of pixel regions is larger and the areas of the pixel regions is smaller. For example, a value obtained by dividing the number of pixel regions by the sum of the areas of the pixel regions may be the above-described evaluation value.

[0062] Further, the degree-of-effectiveness assessing section 115 may assess the degree of effectiveness based on both the degree-of-complexity information obtained as described above and the evaluation value obtained based on the color distribution. For example, the degree-of-effectiveness assessing section 115 may evaluate the degree of effectiveness on a scale of 1 to 5 with use of the degree-of-complexity information and evaluate the degree of effectiveness on a scale of 1 to 5 with use of the evaluation value obtained based on the color distribution. Then, the degree-of-effectiveness assessing section 115 may obtain, as a final degree of effectiveness, an average value of values of those degrees of effectiveness or a weighted average value thereof.

[0063] The method of assessing the degree of mixing effectiveness based on images is not limited to the examples described above. For example, it is possible to evaluate the degree of effectiveness by use of a machine-learned discriminator that uses as, teacher data, a captured image obtained by capturing an image of waste having been subjected to moderate mixing and a captured image obtained by capturing an image of waste having been insufficient mixing.

[Flow of process]

[0064] A flow of a process carried out by the information processing device 1 will be described with reference to Fig. 5. Fig. 5 is a flowchart illustrating an example of a process for updating waste properties at the mixing operation (a method for processing information). Note that a process for updating the waste properties at the restacking operation is similar to the process presented in the example illustrated in Fig. 5. In S1, the crane operation detecting section 111

detects that the crane starts the mixing operation and determines the waste grabbing location in the mixing operation, and then notifies the surface layer shape determining section 112 and the image obtaining section 114 of a determination result.

[0065] In S2, the surface layer shape determining section 112 determines, from measurement data obtained by the range finder 2, the shape of a surface layer of waste in a unit area corresponding to the notified waste grabbing location. In S3, the image obtaining section 114 obtains a pit image 141 which includes an image of the waste grabbing location, and then cuts out the image of the unit area corresponding to the notified waste grabbing location from the obtained image. Then, the image obtaining section 114 transmits the image of the cutout part to the degree-of-effectiveness assessing section 115.

[0066] In S4, the crane operation detecting section 111 detects that the crane has carried out the waste grabbing operation and notifies the surface layer shape determining section 112 of the fact that the crane has carried out the waste grabbing operation. Then, in S5, the surface layer shape determining section 112 having received such notification determines, from measurement data obtained by the range finder 2, the shape of a surface of a waste layer in a unit area corresponding to the waste grabbing location after the waste grabbing operation has been carried out.

[0067] In S6, the crane operation detecting section 111 detects that the crane has carried out the waste release operation and determines the waste release location, and then notifies the image obtaining section 114 of a determination result. Then, in S7, the image obtaining section 114 obtains a pit image 141 which includes an image of a unit area corresponding to the waste release location, and then cuts out the image of the unit area corresponding to the notified waste release location from the obtained image. Then, the image obtaining section 114 transmits the image of the cutout part to the degree-of-effectiveness assessing section 115.

[0068] In S8 (specific gravity calculating step), the specific gravity calculating section 113 calculates, from the determination results obtained in S2 and S5, a specific gravity of the waste having been mixed through the mixing operation the start of which was detected in S1. The method of calculating the specific gravity is as described with reference to Fig. 3. Then, the specific gravity calculating section 113 notifies the waste properties updating section 116 of the calculated specific gravity.

[0069] In S9, the degree-of-effectiveness assessing section 115 evaluates, based on the image obtained in S3, waste properties of the waste before being subjected to the mixing, and evaluates, from the image obtained in S7, waste properties of the waste after having been subjected to the mixing. Then, in S10 (degree-of-effectiveness assessing step), the degree-of-effectiveness assessing section 115 assesses the degree of mixing effectiveness of the mixing operation the start of which was detected in S1, and then notifies the waste properties updating section 116 of an assessment result. The method of evaluating the waste properties and the method of assessing the degree of effectiveness are as described with reference to Fig. 4.

[0070] In S11 (updating step), the waste properties updating section 116 updates waste properties of the unit area corresponding to the waste release location in the waste properties information 142, based on the specific gravity calculated in S8 and the assessment result obtained in S10. The method of performing the update is as described with reference to Fig. 2. This ends the process for updating the waste properties. Note that although not illustrated in Fig. 5, the waste properties updating section 116 updates the waste properties of the unit area corresponding to the waste grabbing location if necessary.

[0071] Since the information processing device 1 updates the waste properties information 142 at any time by the process described above, it is possible to accurately grasp the waste properties distributions at all times. This makes it possible to perform appropriate automatic crane control using the waste properties information 142, such that waste having appropriate waste properties is introduced into the hopper, and mixing is carried out so that waste having appropriate waste properties can be prepared before next introduction into the hopper.

[Variation]

[0072] In the above embodiment, there is provided an example case in which the waste properties are updated in consideration of both the specific gravity and the degree of effectiveness. However, the waste properties may be updated in consideration of only one of them. In a case where only the specific gravity is considered, the image obtaining section 114 and the degree-of-effectiveness assessing section 115 may be omitted. In a case where only the degree of effectiveness is considered, the surface layer shape determining section 112 and the specific gravity calculating section 113 may be omitted.

[0073] Further, the function of the information processing device 1 can also be realized by a plurality of information processing devices which are communicably connected to each other. For example, even in an information processing system in which an information processing device serving as the specific gravity calculating section 113, an information processing device serving as the degree-of-effectiveness assessing section 115, and an information processing device serving as the waste properties updating section 116 are communicably connected to each other, the function which is the same as that of the information processing device 1 can be realized. In this case, the information processing devices

constituting the information processing system may be dispersedly located on a network.

[0074] Further, the crane control device 4 having the waste properties evaluating function of the information processing device 1, a crane control system including such crane control device 4, and a waste incineration plant including such crane control device 4 are also included in the scope of the present invention.

[Example of configuration achieved by software]

[0075] Control blocks of the information processing device 1 (particularly, each section included in the control section 11) can be realized by a logic circuit (hardware) provided in an integrated circuit (IC chip) or the like or can be alternatively realized by software.

[0076] In the latter case, the information processing device 1 includes a computer that executes instructions of a program that is software realizing the foregoing functions. The computer, for example, includes at least one processor and at least one computer-readable storage medium in which the program is stored. An object of the present invention can be achieved by the processor of the computer reading and executing the program stored in the storage medium. Examples of the processor encompass a central processing unit (CPU). Examples of the storage medium encompass a "non-transitory tangible medium" such as a read only memory (ROM), a tape, a disk, a card, a semiconductor memory, and a programmable logic circuit. The computer may further include a random access memory (RAM) or the like in which the program is loaded. Further, the program may be made available to the computer via any transmission medium (such as a communication network and a broadcast wave) which allows the program to be transmitted. Note that an aspect of the present invention can also be achieved in the form of a computer data signal in which the program is embodied via electronic transmission and which is embedded in a carrier wave.

[Supplemental remarks]

[0077] An information processing device in accordance with an embodiment of the present invention is an information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the information processing device including: a degree-of-effectiveness assessing section configured to, when waste has been subjected to mixing in the waste pit, assess a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and an updating section configured to update an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and configured to, in performing the update, adjust a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness.

[0078] According to the above-described configuration, the degree of change of the evaluation of the waste properties is adjusted in consideration of the degree of effectiveness having been assessed based on the image of waste. The above-described configuration makes it possible to more accurately evaluate the waste properties as compared to the configuration in which the waste properties are evaluated based on only the number of times of mixing.

[0079] The above-described information processing device may further include: an initial evaluation determining section configured to, in a case where waste has been brought into the waste pit, determine an initial evaluation of waste properties of a unit area, of the unit areas, corresponding to a location to which the brought-in waste has been dropped, according to at least one of the following factors: a day of the week on which the waste has been brought in, weather of a region from which the brought-in waste has been collected, a type of waste to be collected by a vehicle for bringing in waste, and a region from which the brought-in waste has been collected. According to this configuration, it is possible to appropriately determine an initial evaluation of the waste properties of the brought-in waste.

[0080] The above-described information processing device may further include: an area determining section configured to, in periodically introducing the waste in the waste pit into a waste hopper so that the introduced waste is fed into an incinerator, determine a target unit area, among the unit areas, from which waste is to be introduced into the waste hopper, the area determining section determining the target unit area to be subjected to the introduction such that a difference between an evaluation of waste properties of a target unit area which was determined in the past to be subjected to the introduction and an evaluation of waste properties of a target unit area to be newly determined to be subjected to the introduction falls within a predetermined range. This configuration allows variations in waste properties of waste to be fed into the incinerator to be confined within a predetermined range. This makes it possible to stabilize combustion in the incinerator.

[0081] An information processing device in accordance with an embodiment of the present invention is an information processing device for calculating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the information processing device including: a specific gravity calculating section configured to, when waste has been subjected to mixing in the waste pit, (i) calculate a volume of the waste having been subjected to the mixing from a variation in surface shape of a waste layer between

the waste before being subjected to the mixing and the waste after having been subjected to the mixing and (ii) calculate a specific gravity of the waste from (a) the calculated volume and (b) a weight of the waste having been subjected to the mixing; and an updating section configured to update an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and configured to, in performing the update, adjust a degree of change of the evaluation of the waste properties of the unit area in accordance with the specific gravity.

[0082] According to the above-described configuration, the degree of change of the evaluation of the waste properties is adjusted in consideration of the specific gravity having been calculated based on a variation in surface shape of a waste layer. The above-described configuration makes it possible to more accurately evaluate the waste properties as compared to the configuration in which the waste properties are evaluated based on only the number of times of mixing.

[0083] The above-described information processing device may further include: an area determining section configured to, in periodically introducing the waste in the waste pit into a waste hopper so that the introduced waste is fed into an incinerator, determine a target unit area, among the unit areas, from which waste is to be introduced into the waste hopper, in a case where two or more of the unit areas have waste properties that satisfy a preset criterion for the introduction into the waste hopper, the area determining section determining a unit area, of the two or more unit areas, corresponding to a location into which waste having a relatively low specific gravity as calculated by the specific gravity calculating section was dropped, to be the target unit area to be subjected to the introduction. According to the above-described configuration, it is possible to preferentially feed into the incinerator waste which has a low specific gravity and thus is more likely to be easy to combust.

[0084] A method for processing information in accordance with an embodiment of the present invention is a method for processing information by use of an information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the method including: a degree-of-effectiveness assessing step of, when waste has been subjected to mixing in the waste pit, assessing a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and an updating step of updating an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and, in performing the update, adjusting a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness. This information processing method produces effects similar to those produced by the information processing device.

[0085] A method for processing information in accordance with an embodiment of the present invention is a method for processing information by use of an information processing device for calculating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the method including: a specific gravity calculating step of, when waste has been subjected to mixing in the waste pit, (i) calculating a volume of the waste having been subjected to the mixing from a variation in surface shape of a waste layer between the waste before being subjected to the mixing and the waste after having been subjected to the mixing and (ii) calculating a specific gravity of the waste from (a) the calculated volume and (b) a weight of the waste having been subjected to the mixing; and an updating step of updating an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and, in performing the update, adjusting a degree of change of the evaluation of the waste properties of the unit area in accordance with the specific gravity. This information processing method produces effects similar to those produced by the information processing device.

[0086] The information processing device in accordance with the foregoing aspects of the present invention can be realized by a computer. The computer is operated based on (i) an information processing program for causing the computer to realize the information processing device by causing the computer to operate as each section (software element) included in the information processing device and (ii) a computer-readable storage medium in which the information processing program is stored. Such an information processing program and a computer-readable storage medium are included in the scope of the present invention.

[0087] The present invention is not limited to the embodiments, but can be altered by a skilled person in the art within the scope of the claims. The present invention also encompasses, in its technical scope, any embodiment derived by combining technical means disclosed in differing embodiments.

Reference Signs List

[0088]

1: Information processing device
113: Specific gravity calculating section
115: Degree-of-effectiveness assessing section

116: Waste properties updating section (updating section)
119: Area determining section

Claims

1. An information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the information processing device comprising:

   a degree-of-effectiveness assessing section configured to, when waste has been subjected to mixing in the waste pit, assess a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and
   an updating section configured to update an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and configured to, in performing the update, adjust a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness.

2. The information processing device according to claim 1, further comprising:
   an initial evaluation determining section configured to, in a case where waste has been brought into the waste pit, determine an initial evaluation of waste properties of a unit area, of the unit areas, corresponding to a location to which the brought-in waste has been dropped, according to at least one of the following factors: a day of the week on which the waste has been brought in, weather of a region from which the brought-in waste has been collected, a type of waste to be collected by a vehicle for bringing in waste, and a region from which the brought-in waste has been collected.

3. The information processing device according to claim 1 or 2, further comprising:

   an area determining section configured to, in periodically introducing the waste in the waste pit into a waste hopper so that the introduced waste is fed into an incinerator, determine a target unit area, among the unit areas, from which waste is to be introduced into the waste hopper,
   the area determining section determining the target unit area to be subjected to the introduction such that a difference between an evaluation of waste properties of a target unit area which was determined in the past to be subjected to the introduction and an evaluation of waste properties of a target unit area to be newly determined to be subjected to the introduction falls within a predetermined range.

4. An information processing device for calculating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the information processing device comprising:

   a specific gravity calculating section configured to, when waste has been subjected to mixing in the waste pit, (i) calculate a volume of the waste having been subjected to the mixing from a variation in surface shape of a waste layer between the waste before being subjected to the mixing and the waste after having been subjected to the mixing and (ii) calculate a specific gravity of the waste from (a) the calculated volume and (b) a weight of the waste having been subjected to the mixing; and
   an updating section configured to update an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and configured to, in performing the update, adjust a degree of change of the evaluation of the waste properties of the unit area in accordance with the specific gravity.

5. The information processing device according to claim 4, further comprising:

   an area determining section configured to, in periodically introducing the waste in the waste pit into a waste hopper so that the introduced waste is fed into an incinerator, determine a target unit area, among the unit areas, from which waste is to be introduced into the waste hopper,
   in a case where two or more of the unit areas have waste properties that satisfy a preset criterion for the introduction into the waste hopper, the area determining section determining a unit area, of the two or more unit areas, corresponding to a location into which waste having a relatively low specific gravity as calculated by the

specific gravity calculating section was dropped, to be the target unit area to be subjected to the introduction.

6. A method for processing information by use of an information processing device for evaluating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the method comprising:

a degree-of-effectiveness assessing step of, when waste has been subjected to mixing in the waste pit, assessing a degree of effectiveness of the mixing based on an image of the waste before being subjected to the mixing and an image of the waste after having been subjected to the mixing; and
an updating step of updating an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and, in performing the update, adjusting a degree of change of the evaluation of the waste properties of the unit area in accordance with the degree of effectiveness.

7. A method for processing information by use of an information processing device for calculating waste properties of waste deposited in an internal space of a waste pit for each of individual unit areas into which the internal space of the waste pit is divided, the method comprising:

a specific gravity calculating step of, when waste has been subjected to mixing in the waste pit, (i) calculating a volume of the waste having been subjected to the mixing from a variation in surface shape of a waste layer between the waste before being subjected to the mixing and the waste after having been subjected to the mixing and (ii) calculating a specific gravity of the waste from (a) the calculated volume and (b) a weight of the waste having been subjected to the mixing; and
an updating step of updating an evaluation of waste properties of a unit area, of the unit areas, corresponding to a location into which the waste having been subjected to the mixing was dropped, and, in performing the update, adjusting a degree of change of the evaluation of the waste properties of the unit area in accordance with the specific gravity.

8. An information processing program for causing a computer to function as an information processing device according to claim 1, the information processing program causing the computer to function as the degree-of-effectiveness assessing section and the updating section.

9. An information processing program for causing a computer to function as an information processing device according to claim 4, the information processing program causing the computer to function as the specific gravity calculating section and the updating section.

FIG. 1

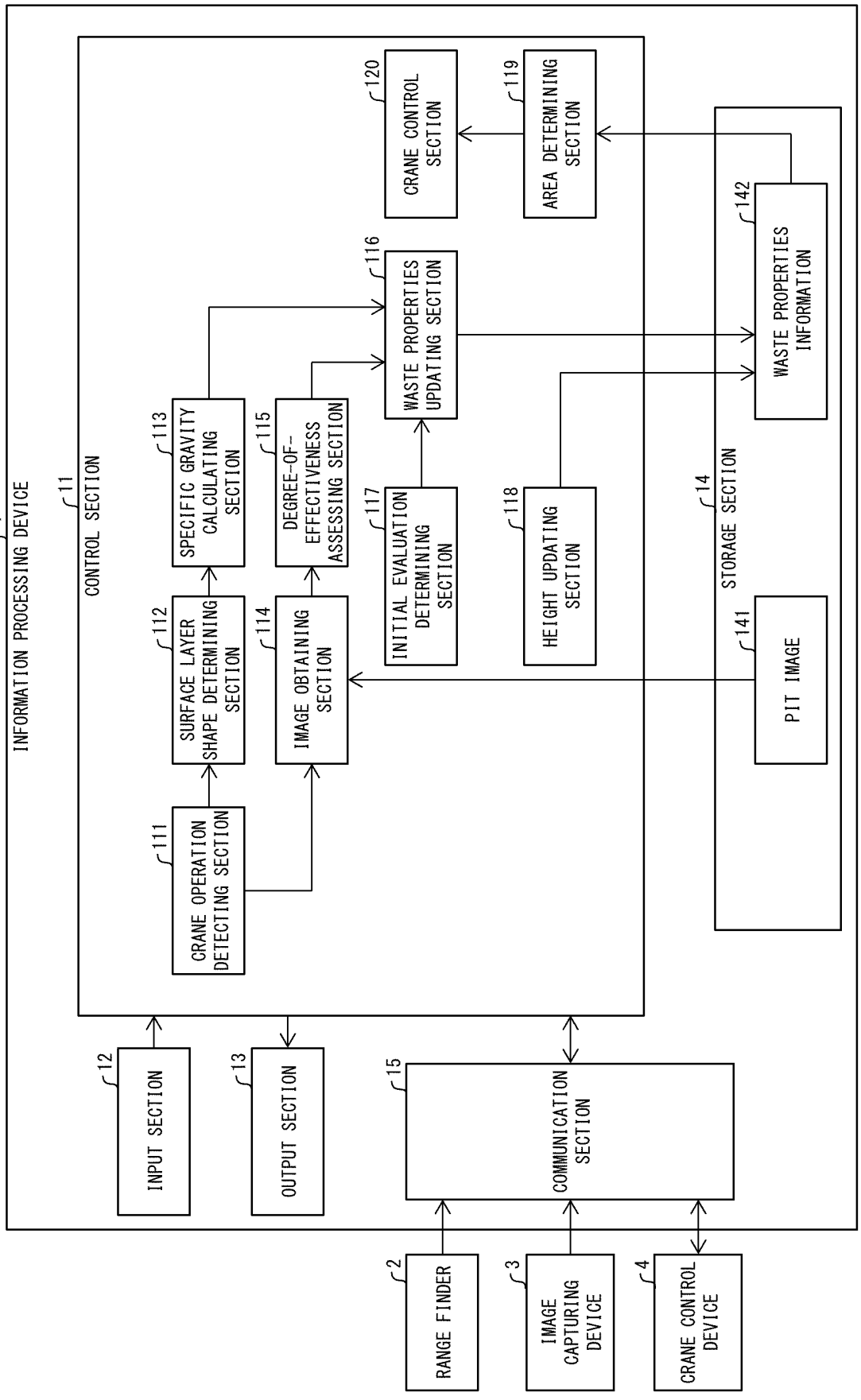
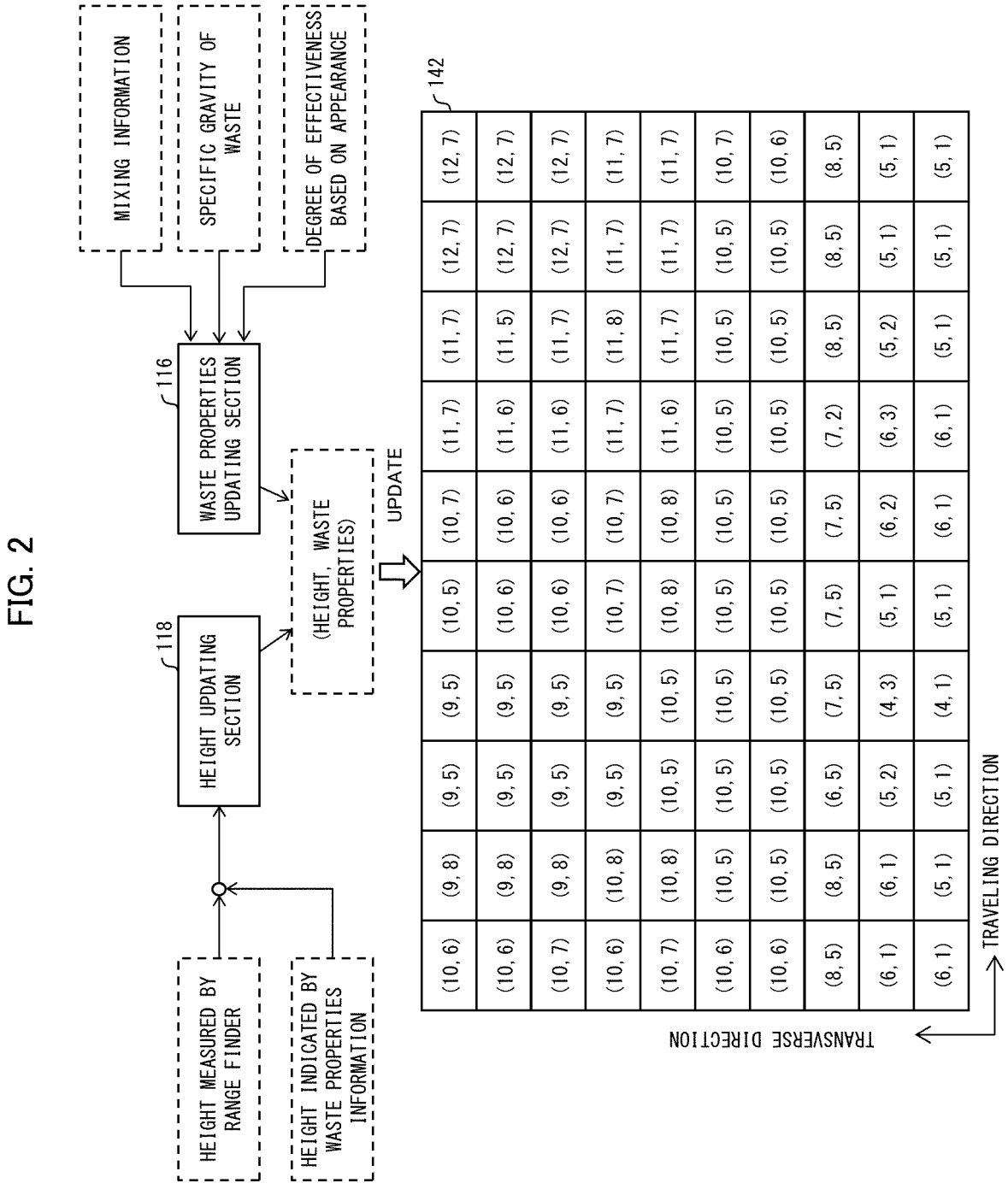

1
INFORMATION PROCESSING DEVICE
11
CONTROL SECTION
111
CRANE OPERATION DETECTING SECTION
112
SURFACE LAYER SHAPE DETERMINING SECTION
113
SPECIFIC GRAVITY CALCULATING SECTION
114
IMAGE OBTAINING SECTION
115
DEGREE-OF-EFFECTIVENESS ASSESSING SECTION
116
WASTE PROPERTIES UPDATING SECTION
117
INITIAL EVALUATION DETERMINING SECTION
118
HEIGHT UPDATING SECTION
119
AREA DETERMINING SECTION
120
CRANE CONTROL SECTION
12
INPUT SECTION
13
OUTPUT SECTION
14
STORAGE SECTION
141
PIT IMAGE
142
WASTE PROPERTIES INFORMATION
15
COMMUNICATION SECTION
2
RANGE FINDER
3
IMAGE CAPTURING DEVICE
4
CRANE CONTROL DEVICE

FIG. 2



(10, 6)	(9, 8)	(9, 5)	(9, 5)	(10, 5)	(10, 7)	(11, 7)	(11, 7)	(12, 7)	(12, 7)	(12, 7)
(10, 6)	(9, 8)	(9, 5)	(9, 5)	(10, 6)	(10, 6)	(11, 6)	(11, 5)	(12, 7)	(12, 7)	(12, 7)
(10, 7)	(9, 8)	(9, 5)	(9, 5)	(10, 6)	(10, 6)	(11, 6)	(11, 7)	(12, 7)	(12, 7)	(12, 7)
(10, 6)	(10, 8)	(9, 5)	(9, 5)	(10, 7)	(10, 7)	(11, 7)	(11, 8)	(11, 7)	(11, 7)	(11, 7)
(10, 7)	(10, 8)	(10, 5)	(10, 5)	(10, 8)	(10, 8)	(11, 6)	(11, 7)	(11, 7)	(11, 7)	(11, 7)
(10, 6)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 7)
(10, 6)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 5)	(10, 6)
(8, 5)	(8, 5)	(6, 5)	(7, 5)	(7, 5)	(7, 5)	(7, 2)	(8, 5)	(8, 5)	(8, 5)	(8, 5)
(6, 1)	(6, 1)	(5, 2)	(4, 3)	(5, 1)	(6, 2)	(6, 3)	(5, 2)	(5, 1)	(5, 1)	(5, 1)
(6, 1)	(5, 1)	(5, 1)	(4, 1)	(5, 1)	(6, 1)	(6, 1)	(5, 1)	(5, 1)	(5, 1)	(5, 1)

FIG. 3

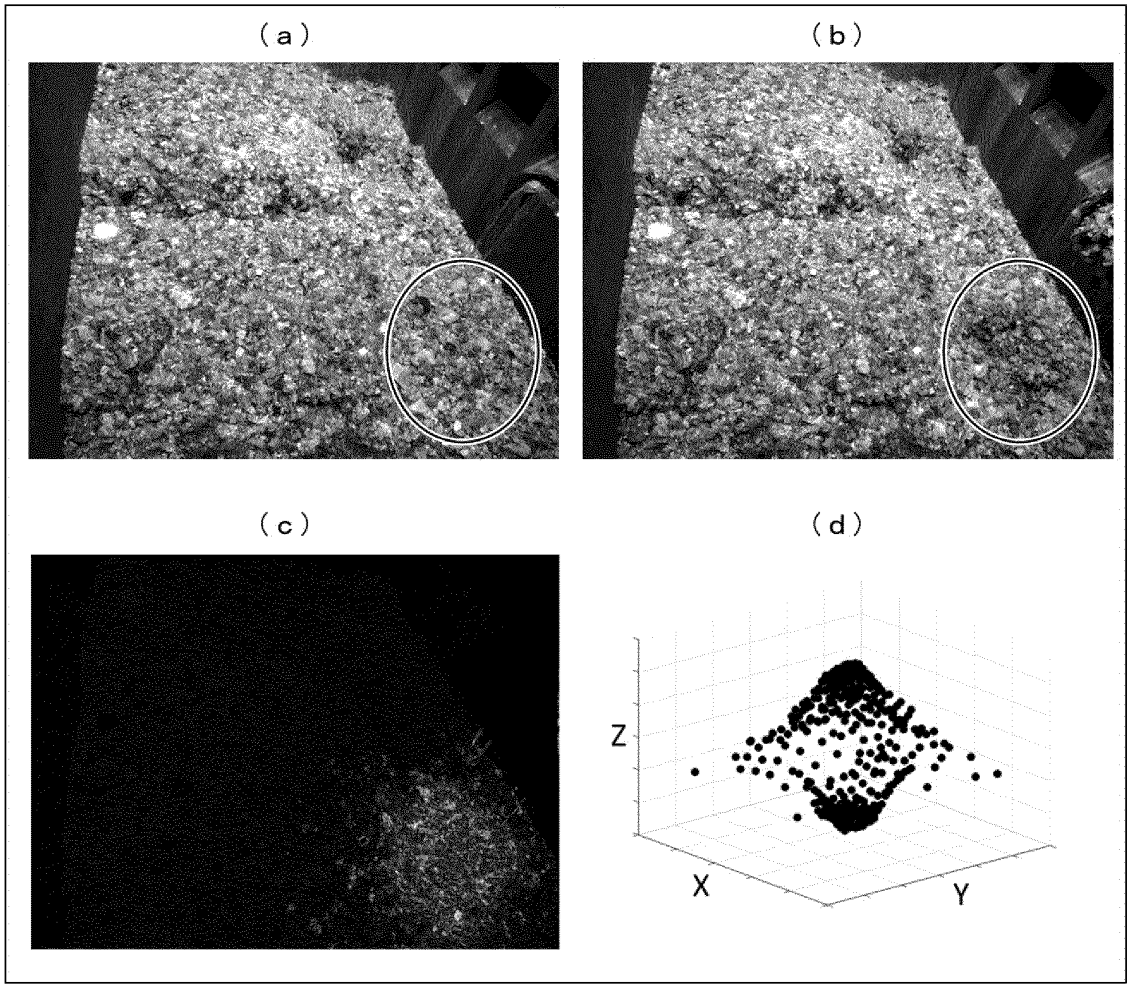


FIG. 4

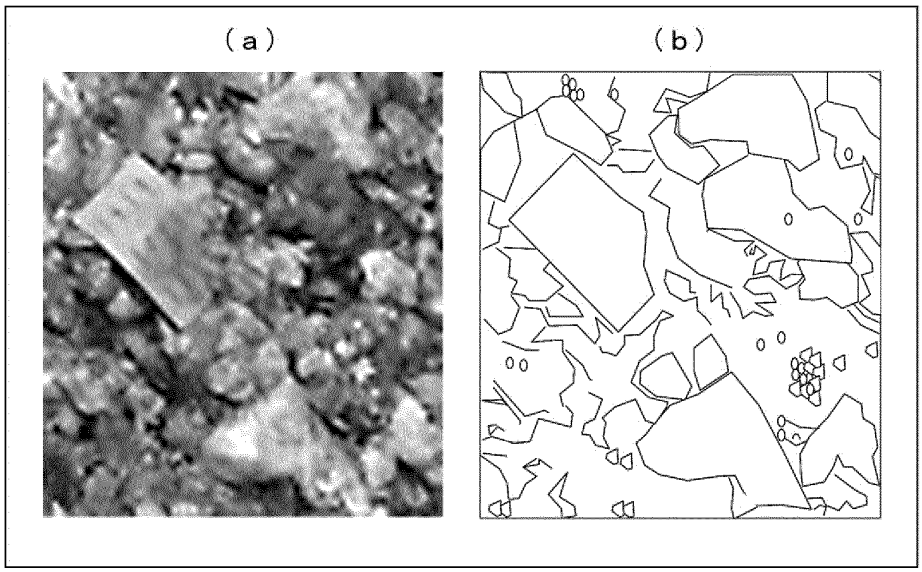
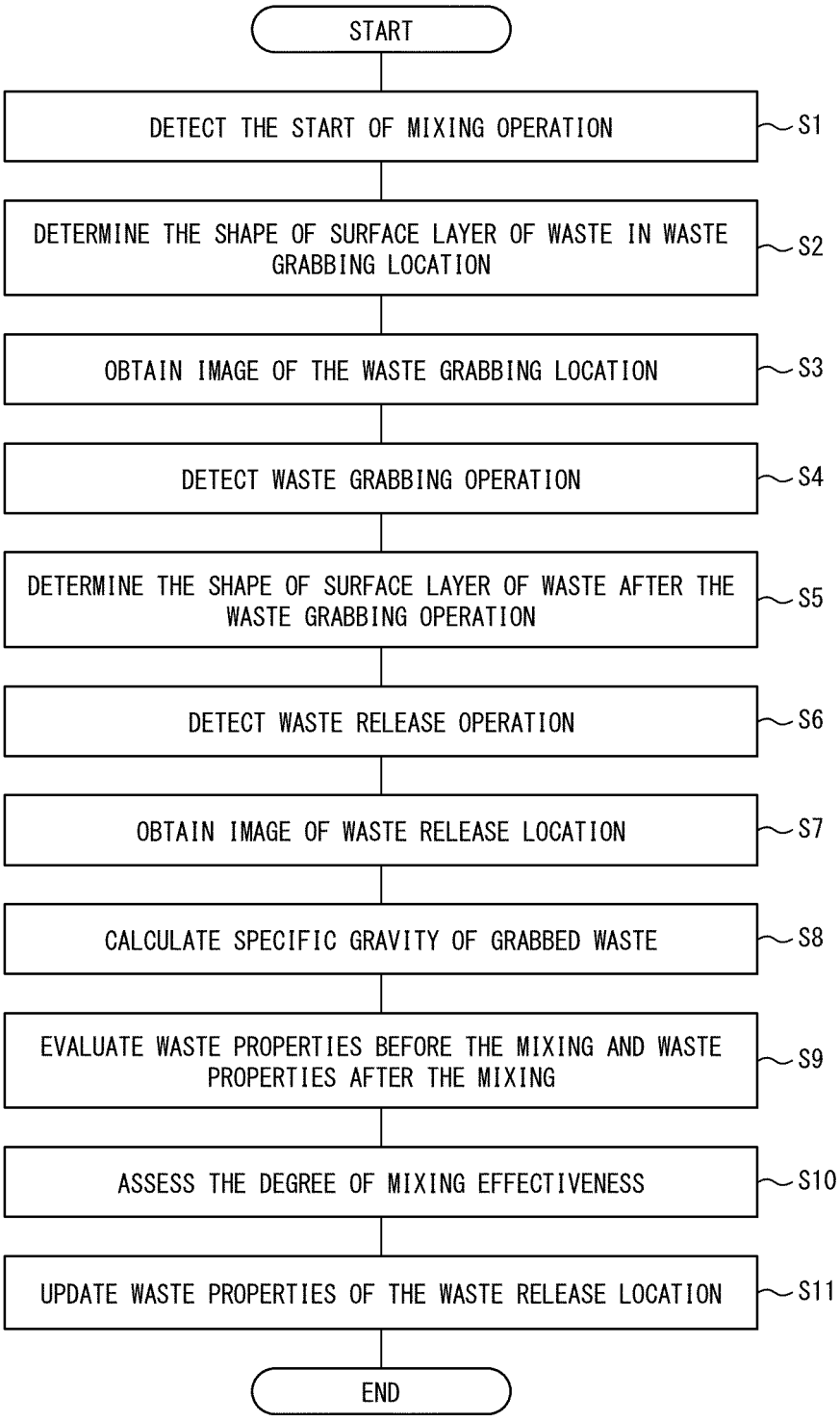


FIG. 5


START
DETECT THE START OF MIXING OPERATION
S1
DETERMINE THE SHAPE OF SURFACE LAYER OF WASTE IN WASTE GRABBING LOCATION
S2
OBTAIN IMAGE OF THE WASTE GRABBING LOCATION
S3
DETECT WASTE GRABBING OPERATION
S4
DETERMINE THE SHAPE OF SURFACE LAYER OF WASTE AFTER THE WASTE GRABBING OPERATION
S5
DETECT WASTE RELEASE OPERATION
S6
OBTAIN IMAGE OF WASTE RELEASE LOCATION
S7
CALCULATE SPECIFIC GRAVITY OF GRABBED WASTE
S8
EVALUATE WASTE PROPERTIES BEFORE THE MIXING AND WASTE PROPERTIES AFTER THE MIXING
S9
ASSESS THE DEGREE OF MIXING EFFECTIVENESS
S10
UPDATE WASTE PROPERTIES OF THE WASTE RELEASE LOCATION
S11
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/038887

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B65F9/00(2006.01)i, F23G5/02(2006.01)i, F23G5/50(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B65F9/00, F23G5/02, F23G5/50

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2017/212891 A1 (HITACHI ZOSEN CORPORATION) 14 December 2017, paragraphs [0032], [0036], [0037], fig. 1-4 & JP 2017-218316 A	1-9
A	JP 2017-030920 A (NOEX INC.) 09 February 2017, paragraphs [0035], [0036] (Family: none)	1-9
A	JP 2014-201424 A (FUJITA CORPORATION) 27 October 2014, paragraph [0002] (Family: none)	1-9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11.01.2019	22.01.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/038887

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2016-069170 A (HITACHI ZOSEN CORPORATION) 09 May 2016, paragraph [0023] (Family: none)	1-9
A	JP 2004-305887 A (HONDA, Shunichiro) 04 November 2004, paragraphs [0001], [0019]-[0022] (Family: none)	1-9
A	JP 11-292045 A (NIIGATA ENGINEERING CO., LTD.) 26 October 1999, paragraphs [0001], [0068] (Family: none)	1-9
A	JP 2015-143139 A (HITACHI ZOSEN CORPORATION) 06 August 2015, paragraphs [0001], [0020] (Family: none)	1-9
A	JP 9-178141 A (KUBOTA CORPORATION) 11 July 1997, paragraphs [0013]-[0017], fig. 1-3 (Family: none)	1-9
A	JP 2007-126246 A (HITACHI PLANT TECHNOLOGIES LTD.) 24 May 2007, paragraphs [0015]-[0022], fig. 1-3 (Family: none)	1-9
A	JP 64-49815 A (KUBOTA IRON WORKS CO., LTD.) 27 February 1989, page 2, upper left column, line 19 to upper right column, line 15, fig. 1, 2 (Family: none)	1-9
A	JP 2-293515 A (BABCOCK HITACHI KK) 04 December 1990, page 2, lower right column, line 18 to page 3, lower right column, line 7, fig. 1-5 (Family: none)	1-9

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010275064 A **[0004]**