

DESCRIPTION

Title of Invention

MOVER MANAGEMENT SYSTEM,
MOVER MANAGEMENT METHOD, AND PROGRAM

Technical Field

[0001] The present disclosure generally relates to a mover management system, a mover management method, and a program. More particularly, the present disclosure relates to a mover management system, a mover management method, and a program, all of which are configured or designed to control the movement of a cleaning device programmed to travel along a predetermined route.

Background Art

[0002] Patent Literature 1 discloses a server (mover management system) including a human movement calculator, a dust collection planner, and a communications unit. The human movement calculator calculates predicted human movement information about the predicted future movement of a person within his or her dwelling facility. The dust collection planner calculates dust collection plan information with a place included in the predicted human movement information preferentially designated as the destination of his or her movement. The communications unit indicates the destination of a dust collecting mover (cleaning device) by transmitting dust collection plan information to the dust collecting mover.

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2021-171359 A

Summary of Invention

[0004] An object of the present disclosure is to provide a mover management system, a mover management method, and a program, all of which are configured or designed to change the traveling route of a cleaning device depending on the situation.

[0005] A mover management system according to an aspect of the present disclosure controls

movement of a cleaning device. The cleaning device travels along a predetermined route. The mover management system includes a processing unit. The processing unit changes the route of the cleaning device depending on the situation in each of a plurality of areas on the route and transmits information about the route thus changed to the cleaning device. The processing unit calculates a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device installed at an arbitrary location around the route, changes the route according to a magnitude of the priority level thus calculated, and transmits information about the route thus changed to the cleaning device. The at least one factor is selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas.

[0006] A mover management method according to another aspect of the present disclosure is designed to control movement of a cleaning device that travels along a predetermined route. The mover management method includes predetermined processing including changing the route of the cleaning device depending on the situation in each of a plurality of areas on the route and transmitting information about the route thus changed to the cleaning device. The predetermined processing includes calculation processing including calculating a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device installed at an arbitrary location around the route. The at least one factor is selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas. The predetermined processing further includes: change processing including changing the route according to a magnitude of the priority level calculated in the calculation processing; and transmission processing including transmitting information about the route changed in the change processing to the cleaning device.

[0007] A program according to still another aspect of the present disclosure is designed to cause one or more processors of a computer system to perform the mover management method described above.

Brief Description of Drawings

[0008] FIG. 1 is a block diagram of a mover management system according to a first embodiment and its associated constituent elements;

FIG. 2 illustrates processing performed by the mover management system;

FIG. 3 illustrates processing performed by the mover management system;

FIG. 4 is a graph showing, along the time axis, a status of use of an area as acquired by

the mover management system; and

FIG. 5 is a flowchart illustrating an exemplary procedure of operation of the mover management system.

Description of Embodiments

[0009] An embodiment of a mover management system 1, a mover management method, and a program according to the present disclosure will be described with reference to the accompanying drawings. Note that the embodiment to be described below is only an exemplary one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure. The drawings to be referred to in the following description of embodiments are all schematic representations. Thus, the ratio of the dimensions of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio.

[0010] (First embodiment)

(Overview)

A cleaning device 2 (mover) travels inside a facility to do cleaning. Examples of the “facility” as used herein include dwelling houses, stores, office buildings, factories, warehouses, shopping malls, libraries, art museums, museums, amusement facilities, theme parks, public parks, airports, railway stations, ballparks, hotels, and hospitals. Alternatively, the “facility” may also be a moving vehicle such as a watercraft or a railway train. Furthermore, the “facility” may be an indoor facility or an outdoor facility, whichever is appropriate.

[0011] The number of the cleaning devices 2 may be one or two or more. The following description of embodiments will be focused on one cleaning device 2.

[0012] The mover management system 1 controls movement of the cleaning device 2. The cleaning device 2 travels along a predetermined route. As shown in FIG. 1, the mover management system 1 includes a processing unit 13. The processing unit 13 changes the route of the cleaning device 2 depending on the situation in each of a plurality of areas on the route and transmits information about the route thus changed to the cleaning device 2. The processing unit 13 calculates a priority level of each of the plurality of areas based on at least one factor derived from the information provided by a monitor device 3 installed at an arbitrary location around the route, changes the route according to the magnitude of the priority level thus calculated, and transmits information about the route thus changed to the cleaning device 2. The at least one factor is selected from the group consisting of the frequency of use of each of the plurality of areas,

duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas.

[0013] This embodiment allows the traveling route of the cleaning device 2 to be changed depending on the situation. For example, some of the plurality of areas is estimated, based on the frequency of use, the duration of use, or environmental data, to have a relatively high degree of dirtiness. The mover management system 1 may change the route of the cleaning device 2 to make the cleaning device 2 to visit and clean such an area preferentially, thus allowing for keeping the facility clean.

[0014] In addition, as shown in FIG. 1, a mover system 100 includes the mover management system 1 and one or more cleaning devices 2.

[0015] The functions of the mover management system 1 may also be implemented as a mover management method. A mover management method according to this embodiment is designed to control movement of a cleaning device 2 that travels along a predetermined route. The mover management method includes predetermined processing including changing the route of the cleaning device 2 depending on the situation in each of a plurality of areas on the route and transmitting information about the route thus changed to the cleaning device 2. The predetermined processing includes calculation processing including calculating a priority level of each of the plurality of areas based on at least one factor derived from the information provided by a monitor device 3 installed at an arbitrary location around the route. The at least one factor is selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas. The predetermined processing further includes: change processing including changing the route according to the magnitude of the priority level calculated in the calculation processing; and transmission processing including transmitting information about the route changed in the change processing to the cleaning device 2.

[0016] The mover management method may also be implemented as a program. A program according to this embodiment is designed to cause one or more processors of a computer system to perform the mover management method described above. The program may be stored in a non-transitory storage medium which is readable for a computer system.

[0017] (Details)

(1) Overall configuration

Next, the mover management system 1 according to this embodiment and its associated constituent elements will be described in further detail.

[0018] As shown in FIG. 1, the mover management system 1 may be used along with, for

example, one or more cleaning devices 2, a plurality of monitor devices 3, a positioning terminal 4, and a beacon terminal 5.

[0019] (2) Mover management system

The mover management system 1 controls the movement of the cleaning device 2 by transmitting information for use to change the traveling route of the cleaning device 2 to the cleaning device 2. The mover management system 1 may include, for example, a communications unit 11, a storage unit 12, and a processing unit 13.

[0020] The communications unit 11 includes a communications interface device. The communications unit 11 is ready to communicate with the cleaning device 2, the plurality of monitor devices 3, and the positioning terminal 4 via the communications interface device. As used herein, the phrase “to be ready to communicate” means being able to transmit and receive signals either directly or indirectly via a network or a repeater, for example, by an appropriate wired or wireless communication method. The communications unit 11 according to this embodiment establishes communication by wireless communication method.

[0021] The storage unit 12 is a storage device implemented as, for example, a hard disk drive (HDD) or a solid-state drive (SSD). The storage unit 12 stores, for example, map information of the facility in which the cleaning device 2 travels.

[0022] The mover management system 1 includes a computer system including one or more processors and a memory. At least some functions of the mover management system 1 are performed by making the processor of the computer system execute a program stored in the memory of the computer system. The program may be stored in the memory. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored in a non-transitory storage medium such as a memory card.

[0023] The processing unit 13 includes one or more processors. The processing unit 13 performs a predetermined function by executing a program. For example, the processing unit 13 either determines or changes the traveling route of the cleaning device 2.

[0024] (3) Cleaning device

As shown in FIG. 1, the cleaning device 2 may include, for example, a communications unit 21, a storage unit 22, a processing unit 23, a traveling mechanism 24, a cleaner 25, a sensor 26, and an operating unit 27.

[0025] The cleaning device 2 travels autonomously along a predetermined route. The cleaning device 2 may include, for example, a camera serving as the sensor 26. When detecting any obstacle present in the traveling direction using the camera, the cleaning device 2 travels while avoiding the obstacle. As can be seen, when avoiding the obstacle, for example, the cleaning

device 2 temporarily deviates from the route but will be back to the original route after that. In addition, the cleaning device 2 makes the sensor 26 detect any litter present around the route and removes the litter thus detected.

[0026] The communications unit 21 includes a communications interface device. The communications unit 21 is ready to communicate with the mover management system 1 via the communications interface device. The communications unit 21 according to this embodiment establishes communication by wireless communication method.

[0027] The storage unit 22 is a storage device implemented as, for example, a hard disk drive (HDD) or a solid-state drive (SSD). The storage unit 22 stores, for example, identification information of its own device (i.e., the cleaning device 2) and map information of the facility in which the cleaning device 2 travels.

[0028] The cleaning device 2 includes a computer system including one or more processors and a memory. At least some functions of the cleaning device 2 are performed by making the processor of the computer system execute a program stored in the memory of the computer system. The program may be stored in the memory. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored in a non-transitory storage medium such as a memory card.

[0029] The processing unit 23 includes one or more processors. The processing unit 23 performs a predetermined function by executing a program. For example, the processing unit 23 controls the transmission and reception of signals by the communications unit 21, the operation of the traveling mechanism 24, and the operation of the cleaner 25.

[0030] The traveling mechanism 24 may include, for example, wheels and a motor for driving the wheels. The traveling mechanism 24 causes the cleaning device 2 to travel under the control of the processing unit 23.

[0031] The cleaner 25 performs at least one of operations including, for example, wiping, sweeping, and sucking up litter (such as dust and dirt). This allows the cleaner 25 to remove the litter present around the cleaning device 2.

[0032] The cleaner 25 may include, for example, a vacuum cleaner. The vacuum cleaner removes the litter by sucking up the litter. The cleaning device 2 further includes, for example, a litter bag for collecting the litter sucked up by the vacuum cleaner.

[0033] The cleaner 25 may further include, for example, a mop and a drive motor for driving the mop and wipe the floor surface by using the mop.

[0034] The cleaner 25 may further include, for example, a brush and a drive motor for driving the brush and sweep the floor surface by using the brush.

[0035] The sensor 26 includes, as a constituent element for detecting the surrounding situation, at least one device selected from the group consisting of, for example, a camera, a laser rangefinder, an infrared light sensor, and a pressure sensor. The processing unit 23 controls the traveling mechanism 24 based on the result of detection by the sensor 26. For example, the processing unit 23 controls the traveling mechanism 24 to avoid the obstacle detected by the sensor 26.

[0036] In addition, the sensor 26 further includes, as a constituent element for detecting the location of its own device (i.e., the cleaning device 2), at least one device selected from the group consisting of, for example, a camera, an acceleration sensor, a gyrosensor, a global positioning system (GPS) sensor, and a global navigation satellite system (GNSS) sensor. The processing unit 23 detects the location of its own device (i.e., the cleaning device 2) based on the result of detection by the sensor 26. More specifically, the processing unit 23 determines, by reference to the map information of the facility stored in the storage unit 22, where in the facility its own device (i.e., the cleaning device 2) is currently located.

[0037] The operating unit 27 may include, for example, at least one selected from the group consisting of a button, a touchscreen panel, and a touchscreen panel display. The operating unit 27 accepts the administrator's operating command. The administrator is allowed to enter various types of settings into the cleaning device 2 by operating the operating unit 27.

[0038] (4) Air quality sensor and powdery dust sensor

The monitor device 3 may include, for example, a plurality of air quality sensors 31 and a plurality of powdery dust sensors 32. The plurality of air quality sensors 31 and the plurality of powdery dust sensors 32 are installed in a plurality of areas inside the facility. For example, one or more air quality sensors 31 and one or more powdery dust sensors 32 are installed per area.

[0039] Each of the air quality sensors 31 detects the air quality as environmental data about its corresponding area. The air quality may be represented by, for example, the concentration of a predetermined substance. The predetermined substance may be, for example, carbon dioxide. In that case, the air quality sensor 31 includes a carbon dioxide sensor. Alternatively, the predetermined substance may also be carbon monoxide, for example.

[0040] Each of the powdery dust sensors 32 detects the amount of powdery dust as environmental data about its corresponding area.

[0041] The results of detection obtained by the plurality of air quality sensors 31 and the plurality of powdery dust sensors 32 are transmitted to the mover management system 1. These results of detection correspond to the environmental data.

[0042] The storage unit 12 of the mover management system 1 stores respective pieces of location information of the plurality of air quality sensors 31 and the plurality of powdery dust

sensors 32 and respective pieces of location information of the plurality of areas. Take one area, for example. The processing unit 13 of the mover management system 1 treats the respective results of detection obtained by the plurality of air quality sensors 31 and the plurality of powdery dust sensors 32 that are installed in that area as environmental data about that area.

[0043] The processing unit 13 of the mover management system 1 estimates the degree of dirtiness on an area-by-area basis by reference to the environmental data. For example, the higher the concentration of carbon dioxide or carbon monoxide detected is, the higher the degree of dirtiness estimated by the processing unit 13 will be. Also, the larger the amount of powdery dust per unit area is, the higher the degree of dirtiness estimated by the processing unit 13 will be.

[0044] Optionally, the monitor device 3 may include only the air quality sensors 31 or only the powdery dust sensors 32.

[0045] (5) Beacon terminal

The user of the plurality of areas of the facility where the cleaning device 2 travels carries one or more beacon terminals 5. Examples of the beacon terminals 5 include cellphones (including smartphones), tablet computers, and wearable terminals.

[0046] Each of the beacon terminals 5 transmits a beacon signal including identification information about its own device (i.e., the beacon terminal 5). The beacon terminal 5 may transmit beacon signals at regular intervals, for example.

[0047] (6) Scanner

The monitor device 3 may include, for example, a plurality of scanners 33. The plurality of scanners 33 are installed in the plurality of areas of the facility in which the cleaning device 2 travels. The plurality of scanners 33 may be installed, for example, on the ceiling of the facility. Each of the scanners 33 receives a beacon signal transmitted from the beacon terminal 5. In addition, each scanner 33 measures the received signal strength indicator (RSSI) of the beacon signal received.

[0048] Each scanner 33 transmits a signal, carrying information about the RSSI of the beacon signal received, identification information included in the beacon signal (i.e., the identification information of the beacon terminal 5), and identification information of its own device (scanner 33), to the positioning terminal 4.

[0049] (7) Positioning terminal

The positioning terminal 4 calculates the user's location based on a beacon signal that has been transmitted from the beacon terminal 5 and received at the scanner 33 (monitor device 3).

[0050] The positioning terminal 4 stores respective pieces of location information of the plurality of scanners 33.

[0051] As described above, each scanner 33 transmits a signal, carrying information about the RSSI of the beacon signal received, identification information of the beacon terminal 5 as the transmission source, and identification information of its own device (scanner 33), to the positioning terminal 4. The positioning terminal 4 receives that signal. The positioning terminal 4 determines, based on the RSSI measured by three or more scanners 33 belonging to the plurality of scanners 33, the distance between the beacon terminal 5 as the transmission source and each of the three or more scanners 33. In addition, the positioning terminal 4 determines, based on the distance, the location of the beacon terminal 5 by triangulation. The positioning terminal 4 transmits information thus acquired about the location of the beacon terminal 5 as a piece of information about the location of the user who carries the beacon terminal 5 to the mover management system 1. The processing unit 13 of the mover management system 1 receives the information about the user's location via the communications unit 11.

[0052] (8) Plurality of areas

Next, the plurality of areas will be described. As shown in FIG. 2, the facility includes a plurality of areas A1–A11. Each of the plurality of areas A1–A11 is an area on the traveling route of the cleaning device 2. That is to say, each of the plurality of areas A1–A11 is an area to be cleaned by the cleaning device 2. Note that some parts of the facility (such as some rooms off the route) may not be “areas” in the context of the present disclosure.

[0053] Information about the traveling route of the cleaning device 2 is shared by the mover management system 1 and the cleaning device 2. The route in the initial state before the route is changed by the processing unit 13 may be determined by either the processing unit 13 of the mover management system 1 or the processing unit 23 of the cleaning device 2, whichever is appropriate. Still alternatively, the route in the initial state may also be determined by the administrator and entered into the mover management system 1.

[0054] Information used to divide the space included in the facility into the plurality of areas is shared by the mover management system 1 and the cleaning device 2. The information used to divide the space included in the facility into the plurality of areas may be, for example, determined by the processing unit 13 of the mover management system 1 or determined by the administrator and entered into the mover management system 1, whichever is appropriate. Also, each room may be regarded as a single area. Alternatively, each room may include two or more areas. Still alternatively, a single area may be defined as covering two or more rooms.

[0055] Also, a plurality of larger areas LA1–LA3 are set as shown in FIG. 2. Each larger area includes two or more areas. In FIG. 2, a larger area LA1 includes areas A1–A4, a larger area LA2 includes areas A5–A7, and a larger area LA3 includes areas A10 and A11.

[0056] The information for use to divide the space included in the facility into a plurality of larger areas may be, for example, determined by the processing unit 13 of the mover management system 1 or determined by the administrator and entered into the mover management system 1, whichever is appropriate.

[0057] (9) Calculating priority level

Next, it will be described how the processing unit 13 of the mover management system 1 performs the processing of calculating the priority level of each of the plurality of areas of the facility.

[0058] The processing unit 13 acquires at least one factor selected from the group consisting of the frequency of use of each of the plurality of areas, the duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas and calculates the priority level based on the at least one factor. In the following description, it will be described how the processing unit 13 calculates the priority level based on the three factors, namely, the frequency of use, the duration of use, and the environmental data.

[0059] The processing unit 13 determines the frequency of use based on the user's location determined by the positioning terminal 4. More specifically, the processing unit 13 defines the frequency of use to be the number of times the user has entered and left a certain area. For example, if the certain area is a meeting room, then the frequency of use of the area corresponds to the number of times that the user has entered and left the meeting room.

[0060] Also, the processing unit 13 determines the duration of use based on the user's location determined by the positioning terminal 4. More specifically, the processing unit 13 defines the duration of use to be the total amount of time for which the user has stayed in a given area.

[0061] An exemplary status of use of a certain area determined by the positioning terminal 4 is shown in FIG. 4. For example, the processing unit 13 determines that as for a period for which one or more users are staying in a certain area, the area should be being used for that period. On the other hand, the processing unit 13 determines that as for a period for which not a single user is staying in that area, the area should not be being used (hereinafter referred to as "no use").

[0062] For example, in the example shown in FIG. 4, the number of times that the status of use of the area has changed from "no use" into "being used" from a time t1 through a time t2 is four times. Thus, the processing unit 13 determines the frequency of use of the area from the time t1 through the time t2 to be four times.

[0063] In another example, the processing unit 13 may count the frequency of use every time a person, different from the person who has just used one area, uses that area. For example, suppose a situation where there are three users, namely, Users A, B, and C; User A uses one area

for 0.5 hours and then leaves the area to make the status of use of the area “no use” temporarily; and then the User A uses the same area again for 1.5 hours. In that case, the frequency of use is only once so far. If User A leaves the same area after that to make the status of use of the area “no use” temporarily and then User B uses the same area for 1 hour, then the frequency of use is twice so far. If User B leaves the same area after that to make the status of use of the area “no use” temporarily and then User C uses the same area for 0.5 hours, then the frequency of use is three times so far.

[0064] The processing unit 13 raises the priority level as the frequency of use increases. For example, the processing unit 13 determines a first parameter based on the frequency of use. The processing unit 13 increases the first parameter as the frequency of use increases. The processing unit 13 determines the priority level by an equation including the first parameter as will be described later.

[0065] If the frequency of use is less than three times, for example, the processing unit 13 sets the first parameter at 1. On the other hand, if the frequency of use is three to five times, the processing unit 13 sets the first parameter at 3. If the frequency of use is more than five times, the processing unit 13 sets the first parameter at 5. Although the threshold values for determining the first parameter are supposed to be three times and five times in this example, the threshold value may be changed as appropriate. Also, even though the first parameter is selected from the three values of 1, 3, and 5 in this example, the first parameter may also be selected from other values or selected from two values or four or more values as well. Optionally, the processing unit 13 may change the first parameter continuously according to the frequency of use. For example, the processing unit 13 may make the first parameter proportional to the frequency of use.

[0066] Next, it will be described, as an example, how the duration of use of an area may be determined. In FIG. 4, the total amount of time for which the status of use of the area is “being used” from the time t1 through the time t2 is 3.5 hours. Thus, the processing unit 13 determines the duration of use of the area from the time t1 through the time t2 to be 3.5 hours.

[0067] The processing unit 13 raises the priority level as the duration of use increases. For example, the processing unit 13 determines a second parameter based on the duration of use. The processing unit 13 increases the second parameter as the duration of use increases. The processing unit 13 determines the priority level by an equation including the second parameter as will be described later.

[0068] If the duration of use is less than 1 hour, for example, the processing unit 13 sets the second parameter at 1. If the duration of use is 1 to 2 hours, the processing unit 13 sets the second parameter at 3. If the duration of use is longer than 2 hours, the processing unit 13 sets the second

parameter at 5. Although the threshold values for determining the second parameter are supposed to be 1 hour and 2 hours in this example, the threshold value may be changed as appropriate. Also, even though the second parameter is selected from the three values of 1, 3, and 5 in this example, the second parameter may also be selected from other values or selected from two values or four or more values as well. Optionally, the processing unit 13 may change the second parameter continuously according to the duration of use. For example, the processing unit 13 may make the second parameter proportional to the duration of use.

[0069] Next, the relationship between the environmental data about an area and the priority level will be described. For example, the processing unit 13 determines a third parameter based on the environmental data. In this example, the environmental data is supposed to be carbon dioxide concentration. The processing unit 13 increases the third parameter as the carbon dioxide concentration rises. The processing unit 13 determines the priority level by an equation including the third parameter as will be described later.

[0070] If the carbon dioxide concentration is less than 1000 ppm, for example, the processing unit 13 sets the third parameter at 1. If the carbon dioxide concentration is in the range from 1000 ppm to 1500 ppm, for example, the processing unit 13 sets the third parameter at 3. If the carbon dioxide concentration is greater than 1500 ppm, for example, the processing unit 13 sets the third parameter at 5. Although the threshold values for determining the third parameter are supposed to be 1000 ppm and 1500 ppm in this example, the threshold values may be changed as appropriate. Also, even though the third parameter is selected from the three values of 1, 3, and 5 in this example, the third parameter may also be selected from other values or selected from two values or four or more values as well. Optionally, the processing unit 13 may change the third parameter continuously according to the carbon dioxide concentration. For example, the processing unit 13 may make the third parameter proportional to the carbon dioxide concentration.

[0071] For example, the processing unit 13 determines the priority level based on the first to third parameters by the following Equation (1):

$$\begin{aligned} \text{Priority level} = & (\text{first parameter} \times w1 + \text{second parameter} \times w2 + \text{third parameter} \times w3) \\ & \times (1/3) \end{aligned} \quad (1)$$

where $w1$ – $w3$ are the weights of the first to third parameters, respectively. The weight may be determined by the administrator, for example. The weight may be selected, for example, from the three values of 1, 2, and 3. The administrator may make the weight for a prioritized one of the three indices of the frequency of use, the duration of use, and the environmental data heavier than the weight for any other one of the three indices. For example, if an area that has so high a frequency of use as to be sanitized more urgently should be cleaned by the cleaning device 2

preferentially, then the administrator may set the first parameter at a larger value than the second or third parameter.

[0073] The aggregation period of the frequency of use and the duration of use may be set appropriately. In the example shown in FIG. 4, the frequency of use and the duration of use are aggregated for the (aggregation) period from the time t1 through the time t2. The aggregation period may be a period from a predetermined time (e.g., the start of a workday if the facility is an office) through the present. Alternatively, the aggregation period may also be a period from a time earlier than the present by a predetermined amount of time through the present. Still alternatively, the aggregation period of the frequency of use and duration of use of a certain area may also be period from a time when the area was cleaned by the cleaning device 2 last time through the present.

[0074] (10) Changing route

Next, it will be described with reference to FIG. 5 how the processing unit 13 makes the cleaning device 2 change its traveling route according to the magnitude of the priority level. Note that the flowchart shown in FIG. 5 is only an exemplary procedure of the mover management method according to the present disclosure and should not be construed as limiting. Optionally, the processing steps shown in FIG. 5 may be performed in a different order from the illustrated one, some of the processing steps shown in FIG. 5 may be omitted as appropriate, and/or an additional processing step may be performed as needed.

[0075] For example, the route in the initial state may be a route along which the cleaning device 2 plans to visit the plurality of areas in the order of A1, A2, A3, ..., and A11 as shown in FIG. 2.

[0076] The processing unit 13 acquires information from the monitor device 3 at regular intervals to calculate the priority level (in Steps ST1 and ST2 shown in FIG. 5). In addition, the processing unit 13 also acquires the location information of the cleaning device 2 (i.e., information about its current location) from the cleaning device 2 at regular intervals (in Step ST3).

[0077] On acquiring the location information of the cleaning device 2, the processing unit 13 determines the area where the cleaning device 2 is currently staying. Next, the processing unit 13 lists areas surrounding the area where the cleaning device 2 is currently staying (in Step ST4). It may be determined by reference to, for example, the map information of the facility whether an area belongs to the areas surrounding the area where the cleaning device 2 is currently staying. In a specify example, the map information includes information indicating the location of a passage through which the cleaning device 2 may pass through. The processing unit 13 calculates the traveling distance that the cleaning device 2 will need to go when traveling from the current location to the area along the passage. If the traveling distance is less than a predetermined

threshold value, then the processing unit 13 determines that the area should belong to the areas surrounding the area where the cleaning device 2 is currently staying. On the other hand, if the traveling distance is equal to or greater than the predetermined threshold value, then the processing unit 13 determines that the area should not belong to those areas surrounding the area where the cleaning device 2 is currently staying.

[0078] In this example, the cleaning device 2 is supposed to be staying in the area A1 shown in FIG. 2 and the surrounding areas are supposed to be areas A2, A3, A5, and A6.

[0079] Next, the processing unit 13 selects an area with the highest priority level from the surrounding areas A2, A3, A5, and A6 (in Step ST5). Then, the processing unit 13 compares the priority level of the area thus selected with a threshold value (in Step ST6). The threshold value is a predetermined value. In this example, the threshold value is supposed to be 10. If the priority level of the selected area is equal to or greater than the threshold value, then the processing unit 13 instructs the cleaning device 2 to change the route to clean the selected area earlier than the other areas (in Step ST7).

[0080] Suppose a situation where the area A5 has a higher priority level than any other one of the surrounding areas A2, A3, A5, and A6 and has a priority level equal to or greater than 10. In that case, the processing unit 13 changes the route. Specifically, the route that has not been changed yet is a route along which the cleaning device 2 is supposed to visit the plurality of areas A1, A2, A3, ..., and A11 in this order. On the other hand, the route that has been changed is a route along which the cleaning device 2 is supposed to visit the areas A1, A5, A2, A3, A4, A6, A7, ..., and A11 in this order (refer to FIG. 3).

[0081] According to the route that has been changed, when finishing cleaning the current area A1, the cleaning device 2 visits the selected area A5 next. When finishing cleaning the area A5, the cleaning device 2 visits the area A2 that the cleaning device 2 planned to visit next to the area A1 at a point in time before the route was changed. When finishing cleaning the area A2, the cleaning device 2 visits and cleans the areas A3 and A4 that the cleaning device 2 planned to visit next to the area A2 at the point in time before the route was changed. At the point in time before the route was changed, the cleaning device 2 planned to visit the area A5 next when finishing cleaning the area A4. However, since the route has been changed, the area A5 has already been cleaned. That is why according to the route that has been changed, the cleaning device 2 is supposed to visit the area A6 next to the area A4 with the area A5 skipped.

[0082] As can be seen, the cleaning device 2 visits the plurality of areas in the predetermined order. If the plurality of areas includes any area having a priority level equal to or greater than the threshold value, then the processing unit 13 changes the predetermined order to make the

cleaning device 2 visit that area preferentially. This allows the cleaning device 2 to clean such an area with the relatively high priority level earlier. For example, the cleaning device 2 cleans an area with a relatively high frequency of use, or a relatively long duration of use, or a relatively high carbon dioxide concentration earlier than other areas. That is to say, the cleaning device 2 cleans an area that would have a relatively high degree of dirtiness or a relatively large amount of litter than other areas.

[0083] In addition, the cleaning device 2 visits the plurality of larger areas in a predetermined order. That is to say, the cleaning device 2 visits the plurality of larger areas LA1–LA3 in the order of LA1, LA2, and LA3. Each of the plurality of larger areas includes two or more areas. Once the cleaning device 2 has entered a larger area, the cleaning device 2 visits all of the two or more areas included in the larger area and then visits the next larger area except in the case of exceptional processing. That is to say, in the instance shown in FIG. 2 to which the exceptional processing is not applicable, the cleaning device 2 visits all of the areas A1–A4 of the larger area LA1 and then visits the next larger area LA2. The cleaning device 2 visits all of the areas A5–A7 included in the larger area LA2. Thereafter, the cleaning device 2 visits the areas A8 and A9 in the order that has been set in advance with respect to the areas A1–A11 and then visits the larger area LA3.

[0084] If a particular area outside of a larger area has a priority level equal to or greater than the threshold value, then the processing unit 13 changes the route, as exceptional processing, to cause the cleaning device 2 to once leave the larger area to visit the particular area and then return to the larger area. For example, in the instance shown in FIG. 3 to which the exceptional processing is applicable, the area A5 outside of the larger area LA1 has a priority level equal to or greater than the threshold value, and therefore, the cleaning device 2 once leaves, after finishing cleaning the area A1, the larger area LA1 to visit the area A5. When finishing cleaning the area A5, the cleaning device 2 returns to the larger area LA1 where the cleaning device 2 once belonged. After having returned to the larger area LA1, the cleaning device 2 visits the areas A2–A4 in the predetermined order.

[0085] (Second embodiment)

Next, a mover management system 1 and mover management method according to a second embodiment will be described. The mover management system 1 according to the second embodiment has the same configuration as the mover management system 1 according to the first embodiment described above. According to the second embodiment, the priority level is calculated differently from in the first embodiment but the other processing is performed in the same way as in the first embodiment.

[0086] In this embodiment, the processing unit 13 calculates the priority level based on not only at least one factor selected from the group consisting of the frequency of use, duration of use, and environmental data of each of the plurality of areas but also the distance between the location of the cleaning device 2 and each of the plurality of areas.

[0087] As described above, the map information includes information indicating the location of a passage through which the cleaning device 2 may pass. As the distance between the location of the cleaning device 2 and the area, not the straight-line distance but the traveling distance in a situation where the cleaning device 2 travels along the passage from the current location to that area is preferably applied. In the following description, the distance between the location of the cleaning device 2 and the area will be hereinafter referred to as a “traveling distance.”

[0088] The processing unit 13 raises the priority level as the traveling distance decreases. For example, the processing unit 13 determines a fourth parameter based on the traveling distance. The processing unit 13 increases the fourth parameter as the traveling distance decreases. The processing unit 13 determines the priority level by an equation including the fourth parameter as will be described later.

[0089] If the traveling distance is less than 3 meters, for example, the processing unit 13 sets the fourth parameter at 15. If the traveling distance is in the range of 3 to 10 meters, the processing unit 13 sets the fourth parameter at 7. If the traveling distance is longer than 10 meters, the processing unit 13 sets the fourth parameter at 1. Although the threshold values for determining the fourth parameter are supposed to be 3 meters and 10 meters in this example, the threshold value may be changed as appropriate. Also, even though the fourth parameter is selected from the three values of 15, 7, and 1 in this example, the fourth parameter may also be selected from other values or selected from two values or four or more values as well. Optionally, the processing unit 13 may change the fourth parameter continuously according to the traveling distance. For example, the processing unit 13 may make the fourth parameter inversely proportional to the traveling distance.

[0090] For example, the processing unit 13 determines the priority level based on the first to fourth parameters by the following Equation (2):

$$\begin{aligned} \text{Priority level} = & (\text{first parameter} \times w1 + \text{second parameter} \times w2 + \text{third parameter} \times w3) \\ & \times (1/6) \times w5 + (\text{fourth parameter} \times w4) \times (1/2) \end{aligned} \quad (2)$$

where $w4$ is the weight of the fourth parameter and $w5$ is a common weight for the first to third parameters. The weight may be determined by the administrator, for example. The administrator may make $w5$ heavier if the frequency of use, duration of use, and environmental data are prioritized and may make $w4$ heavier if the traveling distance is prioritized.

[0092] According to this embodiment, the processing unit 13 may determine, with the traveling distance taken into account, whether the route needs to be changed. More specifically, as for an area that will have a relatively long traveling distance from the current area, cleaning of that area is not prioritized even if the degree of dirtiness of that area would be relatively high. This may reduce the chances of the time it takes for the cleaning device 2 to travel becoming too long.

[0093] (Variations of first and second embodiments)

Next, variations of the first and second embodiments will be enumerated one after another. Note that the variations to be described below may be adopted in combination as appropriate.

[0094] In the embodiments described above, the processing unit 13 changes the original plan to visit the areas by cutting in the visit to one area A5 that would have been visited later to make the cleaning device 2 visit the area A5 earlier than other areas. Thus, the original route that has not been changed yet is generally maintained as it is. However, this is only an example and should not be construed as limiting. Alternatively, the processing unit 13 may newly determine the route to be followed by the cleaning device 2 after the cleaning device 2 has visited the area A5 regardless of the original route that has not been changed yet.

[0095] The processing unit 13 may change the order in which the cleaning device 2 is supposed to visit the two or more areas included in the same larger area. For example, the processing unit 13 may change the route to make the cleaning device 2 visit the area A4 next to the area A1.

[0096] It is not essential for the processing unit 13 to perform processing based on the concept of larger area. That is to say, the larger areas do not have to be set.

[0097] In the embodiments described above, the cleaning device 2 detects the location of its own device (i.e., the cleaning device 2) based on the result of detection by the sensor 26. Alternatively, the location of the cleaning device 2 may be determined based on a beacon signal. In that case, the cleaning device 2 transmits a beacon signal including its own identification information and the plurality of scanners 33 receive the beacon signal. The positioning terminal 4 may determine the location of the cleaning device 2 based on, for example, the RSSI of the beacon signal and transmits information about the location of the cleaning device 2 to the cleaning device 2.

[0098] The positioning terminal 4 may determine the location of the transmission source of the beacon signal based on the phase of the beacon signal, instead of the RSSI of the beacon signal.

[0099] The beacon signal does not have to be used to detect the user's location. Alternatively, the user's location may also be detected by, for example, analyzing an image captured by a camera installed in a facility.

[0100] The mover management system 1 according to the present disclosure or the agent that performs the mover management method according to the present disclosure includes a computer

system. The computer system may include a processor and a memory as principal hardware components thereof. The computer system performs the functions of the mover management system 1 according to the present disclosure or serves as the agent that performs the mover management method according to the present disclosure by making the processor execute a program stored in the memory of the computer system. The program may be stored in advance in the memory of the computer system. Alternatively, the program may also be downloaded through a telecommunications line or be distributed after having been recorded in some non-transitory storage medium such as a memory card, an optical disc, or a hard disk drive, any of which is readable for the computer system. The processor of the computer system may be made up of a single or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or a large-scale integrated circuit (LSI). As used herein, the “integrated circuit” such as an IC or an LSI is called by a different name depending on the degree of integration thereof. Examples of the integrated circuits such as an IC or an LSI include integrated circuits called a “system LSI,” a “very-large-scale integrated circuit (VLSI),” and an “ultra-large-scale integrated circuit (ULSI).” Optionally, a field-programmable gate array (FPGA) to be programmed after an LSI has been fabricated or a reconfigurable logic device allowing the connections or circuit sections inside of an LSI to be reconfigured may also be adopted as the processor. Those electronic circuits may be either integrated together on a single chip or distributed on multiple chips, whichever is appropriate. Those multiple chips may be aggregated together in a single device or distributed in multiple devices without limitation. As used herein, the “computer system” includes a microcontroller including one or more processors and one or more memories. Thus, the microcontroller may also be implemented as a single or a plurality of electronic circuits including a semiconductor integrated circuit or a large-scale integrated circuit.

[0101] Optionally, the plurality of functions aggregated together in a single device in the exemplary embodiment described above may be distributed among multiple devices.

[0102] Conversely, the plurality of functions distributed among a plurality of devices in the exemplary embodiment described above may be aggregated together in a single device. For example, the functions distributed in the mover management system 1 and the positioning terminal 4 may be aggregated together in a single device. That is to say, the mover management system 1 may also serve as the positioning terminal 4.

[0103] (Recapitulation)

The exemplary embodiment and its variations described above are specific implementations of the following aspects of the present disclosure.

[0104] A mover management system (1) according to a first aspect controls movement of a

cleaning device (2). The cleaning device (2) travels along a predetermined route. The mover management system (1) includes a processing unit (13). The processing unit (13) changes the route of the cleaning device (2) depending on a situation in each of a plurality of areas on the route and transmits information about the route thus changed to the cleaning device (2). The processing unit (13) calculates a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device (3) installed at an arbitrary location around the route, changes the route according to a magnitude of the priority level thus calculated, and transmits information about the route thus changed to the cleaning device (2). The at least one factor is selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas.

[0105] This configuration allows the traveling route of the cleaning device (2) to be changed depending on the situation, thus allowing for keeping a given facility clean.

[0106] In a mover management system (1) according to a second aspect, which may be implemented in conjunction with the first aspect, the processing unit (13) calculates the priority level based on a distance between a location of the cleaning device (2) and each of the plurality of areas as well.

[0107] This configuration allows the processing unit (13) to determine, with the distance taken into account, whether or not to change the route.

[0108] In a mover management system (1) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the cleaning device (2) visits the plurality of areas in a predetermined order. The processing unit (13) changes, when the plurality of areas includes an area having the priority level equal to or greater than a threshold value, the predetermined order to cause the cleaning device (2) to preferentially visit the area having the priority level equal to or greater than the threshold value.

[0109] This configuration allows the cleaning device (2) to clean, for example, an area where there will be a lot of dirt and litter, earlier than other areas.

[0110] In a mover management system (1) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, the cleaning device (2) visits a plurality of larger areas in a predetermined order. Each of the plurality of larger areas includes two or more areas. Once the cleaning device (2) has entered a first larger area belonging to the plurality of larger areas, the cleaning device (2) visits all of the two or more areas included in the first larger area and then visits a second larger area next to the first larger area and belonging to the plurality of larger areas, except in a case of exceptional processing. When the priority level

of a particular area outside of the first larger area is equal to or greater than a threshold value, the processing unit (13) changes the route as the exceptional processing to cause the cleaning device (2) to once leave the first larger area to visit the particular area and then return to the first larger area.

[0111] This configuration allows the cleaning device (2) to do cleaning efficiently.

[0112] In a mover management system (1) according to a fifth aspect, which may be implemented in conjunction with any one of the first to fourth aspects, the monitor device (3) includes at least one of: an air quality sensor (31) for detecting an air quality as the environmental data; or a powdery dust sensor (32) for detecting a quantity of powdery dust as the environmental data.

[0113] This configuration allows the processing unit (13) to estimate the degree of dirtiness of a given area based on the environmental data.

[0114] In a mover management system (1) according to a sixth aspect, which may be implemented in conjunction with any one of the first to fifth aspects, the processing unit (13) receives, from a positioning terminal (4) for calculating a location of a user who uses the plurality of areas, information about the user's location. The positioning terminal (4) calculates the user's location based on a beacon signal transmitted from a beacon terminal (5) carried by the user and received at the monitor device (3) installed in the plurality of areas. The processing unit (13) determines at least one of the frequency of use or the duration of use based on the user's location calculated by the positioning terminal (4).

[0115] This configuration allows the frequency of use and/or the duration of use to be determined accurately.

[0116] In a mover management system (1) according to a seventh aspect, which may be implemented in conjunction with any one of the first to sixth aspects, the processing unit (13) determines an area to visit preferentially from areas surrounding an area where the cleaning device (2) is currently staying which belong to the plurality of areas.

[0117] This configuration allows for shortening the distance that the cleaning device (2) needs to travel.

[0118] Note that the constituent elements according to the second to seventh aspects are not essential constituent elements for the mover management system (1) but may be omitted as appropriate.

[0119] A mover management method according to an eighth aspect is designed to control movement of a cleaning device (2) that travels along a predetermined route. The mover management method includes predetermined processing including changing the route of the cleaning device (2) depending on a situation in each of a plurality of areas on the route and

transmitting information about the route thus changed to the cleaning device (2). The predetermined processing includes calculation processing including calculating a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device (3) installed at an arbitrary location around the route. The at least one factor is selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas. The predetermined processing further includes: change processing including changing the route according to a magnitude of the priority level calculated in the calculation processing; and transmission processing including transmitting information about the route changed in the change processing to the cleaning device (2).

[0120] This method allows the traveling route of the cleaning device (2) to be changed depending on the situation, thus allowing for keeping a given facility clean.

[0121] A program according to a ninth aspect is designed to cause one or more processors of a computer system to perform the mover management method according to the eighth aspect.

[0122] This program allows the traveling route of the cleaning device (2) to be changed depending on the situation, thus allowing for keeping a given facility clean.

[0123] Note that these are not the only aspects of the present disclosure but various configurations (including variations) of the mover management system (1) according to the exemplary embodiment described above may also be implemented as, for example, a mover management method, a (computer) program, or a non-transitory storage medium on which the program is stored.

Reference Signs List

[0124]	1	Mover Management System
	2	Cleaning Device
	3	Monitor Device
	4	Positioning Terminal
	5	Beacon Terminal
	13	Processing Unit
	31	Air Quality Sensor
	32	Powdery Dust Sensor

CLAIMS

1. A mover management system configured to control movement of a cleaning device, the cleaning device being configured to travel along a predetermined route, the mover management system comprising

a processing unit configured to change the route of the cleaning device depending on a situation in each of a plurality of areas on the route and transmit information about the route thus changed to the cleaning device,

the processing unit being configured to calculate a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device installed at an arbitrary location around the route, change the route according to a magnitude of the priority level thus calculated, and transmit information about the route thus changed to the cleaning device, the at least one factor being selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas.

2. The mover management system of claim 1, wherein

the processing unit is configured to calculate the priority level based on a distance between a location of the cleaning device and each of the plurality of areas as well.

3. The mover management system of claim 1 or 2, wherein

the cleaning device is configured to visit the plurality of areas in a predetermined order, and

the processing unit is configured to, when the plurality of areas includes an area having the priority level equal to or greater than a threshold value, change the predetermined order to cause the cleaning device to preferentially visit the area having the priority level equal to or greater than the threshold value.

4. The mover management system of any one of claims 1 to 3, wherein

the cleaning device is configured to visit a plurality of larger areas in a predetermined order,

each of the plurality of larger areas includes two or more areas,

the cleaning device is configured to, once the cleaning device has entered a first larger area belonging to the plurality of larger areas, visit all of the two or more areas included in the first larger area and then visit a second larger area next to the first larger area and belonging to the plurality of larger areas, except in a case of exceptional processing, and

the processing unit is configured to, when the priority level of a particular area outside of the first larger area is equal to or greater than a threshold value, change the route as the exceptional processing to cause the cleaning device to once leave the first larger area to visit the particular area and then return to the first larger area.

5. The mover management system of any one of claims 1 to 4, wherein the monitor device includes at least one of:
an air quality sensor configured to detect an air quality as the environmental data; or
a powdery dust sensor configured to detect a quantity of powdery dust as the environmental data.
6. The mover management system of any one of claims 1 to 5, wherein the processing unit is configured to receive, from a positioning terminal configured to calculate a location of a user who uses the plurality of areas, information about the user's location, the positioning terminal is configured to
calculate the user's location based on a beacon signal transmitted from a beacon terminal carried by the user and received at the monitor device installed in the plurality of areas, and
the processing unit is configured to determine at least one of the frequency of use or the duration of use based on the user's location calculated by the positioning terminal.
7. The mover management system of any one of claims 1 to 6, wherein the processing unit is configured to determine an area to visit preferentially from areas surrounding an area where the cleaning device is currently staying which belong to the plurality of areas.
8. A mover management method designed to control movement of a cleaning device, the cleaning device being configured to travel along a predetermined route, the mover management method comprising
predetermined processing including changing the route of the cleaning device depending on a situation in each of a plurality of areas on the route and transmitting information about the

route thus changed to the cleaning device,

the predetermined processing including

calculation processing including calculating a priority level of each of the plurality of areas based on at least one factor derived from information provided by a monitor device installed at an arbitrary location around the route, the at least one factor being selected from the group consisting of a frequency of use of each of the plurality of areas, duration of use of each of the plurality of areas, and environmental data about each of the plurality of areas;

change processing including changing the route according to a magnitude of the priority level calculated in the calculation processing; and

transmission processing including transmitting information about the route changed in the change processing to the cleaning device.

9. A program designed to cause one or more processors of a computer system to perform the mover management method of claim 8.