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Kominami et al.

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(45) **Date of Patent: Aug. 12, 2025**

(54) **INFORMATION MANAGEMENT METHOD, IDENTIFICATION INFORMATION IMPARTING APPARATUS, AND INFORMATION MANAGEMENT SYSTEM**

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B05B 9/04 (2006.01)
B05B 13/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B05B 9/04*** (2013.01); ***B05B 13/0221*** (2013.01); ***B05B 15/00*** (2013.01); ***B05D 1/02*** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

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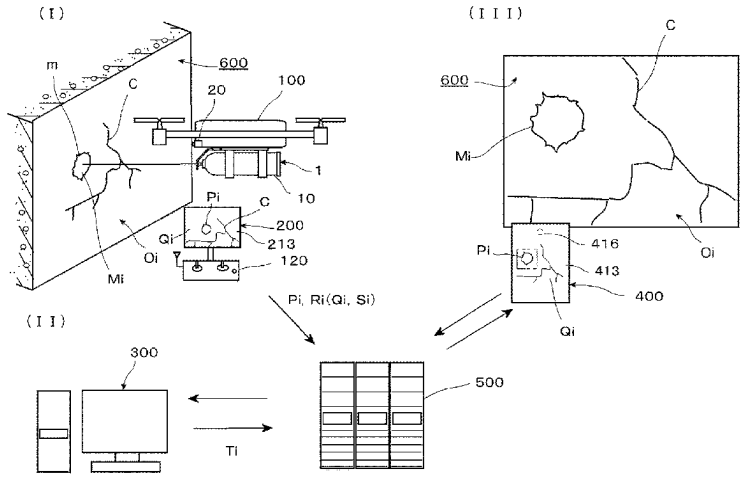
Primary Examiner — Jethro M. Pence
(74) *Attorney, Agent, or Firm* — Marshall, Gerstein & Borun LLP

(57) **ABSTRACT**

Provided are an information management method, an identification information imparting apparatus, and an information management system that use a spray pattern capable of identifying a target object in a simple way. The present invention is characterized by: spraying a liquid material on a part of a target object (Oi) by the liquid material ejection device (**10**) to form an irregular spray pattern (Mi); storing a spray pattern image (Pi), which is obtained by photographing and imaging the spray pattern (Mi), and information (Ri) about the target object in association with each other; and managing the information about the target object using the spray pattern image (Pi) as identification information of the target object.

2 Claims, 12 Drawing Sheets



(51) **Int. Cl.**

B05B 15/00	(2018.01)
B05D 1/02	(2006.01)
B64C 39/02	(2023.01)
B64D 1/18	(2006.01)
H04N 7/18	(2006.01)
B64U 101/30	(2023.01)
B64U 101/45	(2023.01)

(52) **U.S. Cl.**

CPC ***B64D 1/18*** (2013.01); ***H04N 7/18*** (2013.01); *B64U 2101/30* (2023.01); *B64U 2101/45* (2023.01)

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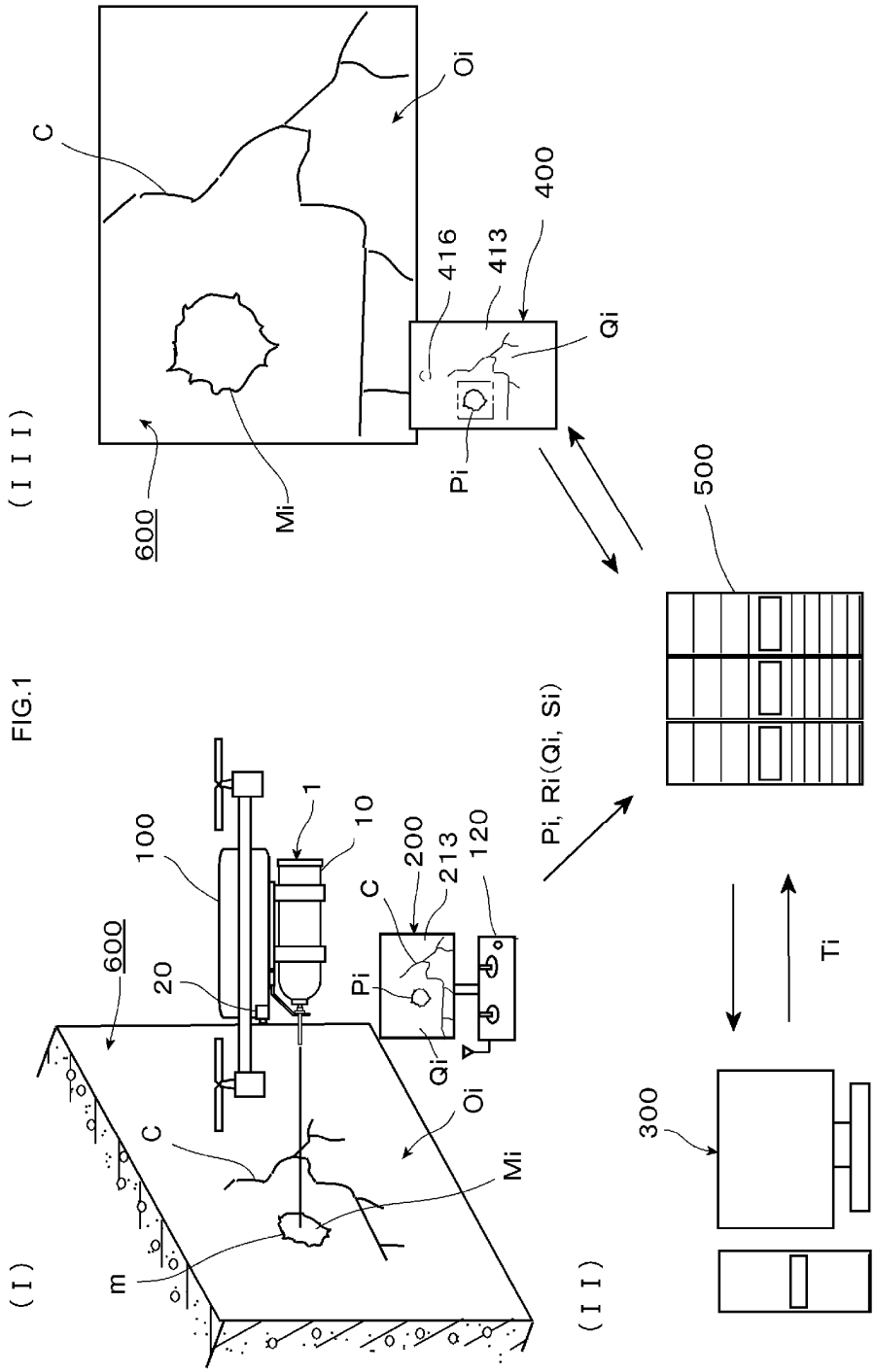

(I I I)
C
Oi
400
416
413
Qi
Pi
600
Mi
500
Pi, Ri(Qi, Si)
FIG.1
(I)
100
1
10
200
213
120
C
600
20
Pi
Qi
Oi
C
Mi
m
Ti
(I I)
300

FIG.2(A)

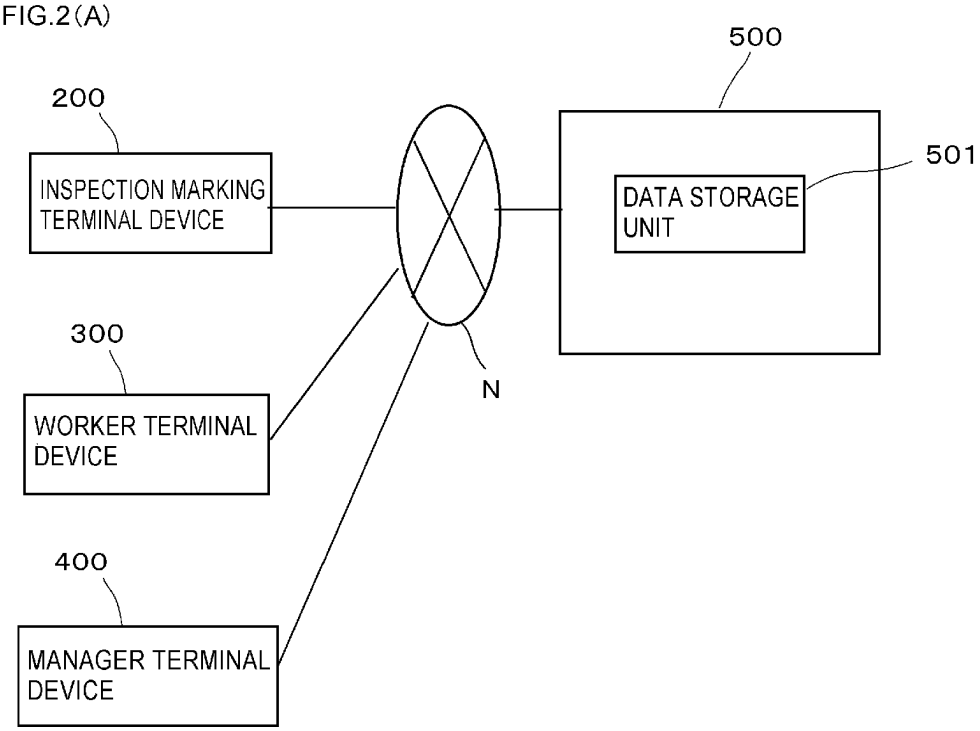


FIG.2(B)

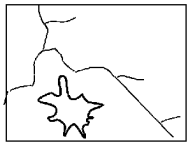
SPRAY PATTERN IMAGE Pi	REPAIR TARGET REGION INFORMATION Ri		
	REPAIR TARGET REGION IMAGE Qi	POSITION INFORMATION Si	CONSTRUCTION CONTENT Ti
		SITE OO TUNNE NORTH LATITUDE 00° 00′ 00″ EAST LONGITUDE ..... ALTITUDE	OO CONSTRUCTION METHOD, x x x x
		SITE OO TUNNE NORTH LATITUDE 00° 00′ 00″ EAST LONGITUDE ..... ALTITUDE	ΔΔ CONSTRUCTION METHOD x x x x

FIG.3(A)

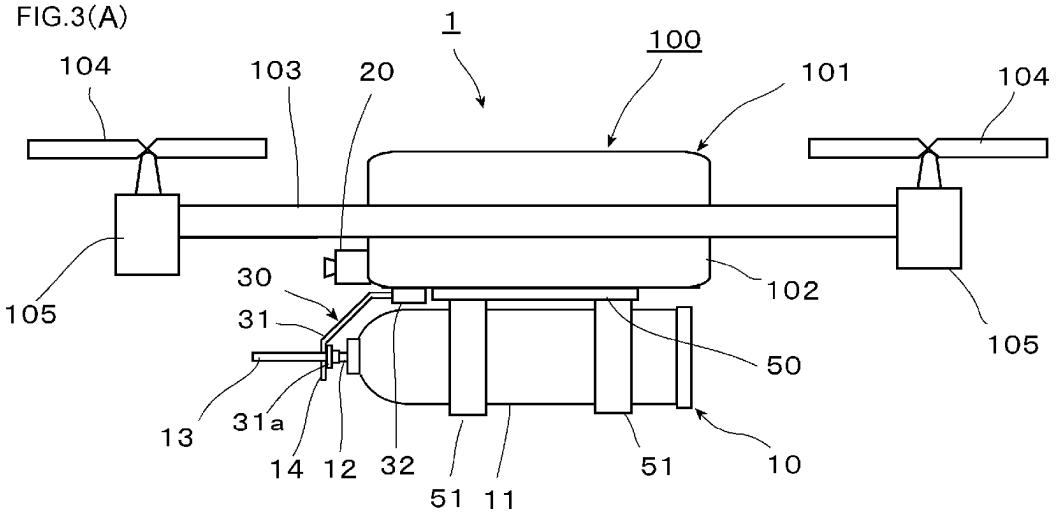


FIG.3(B)

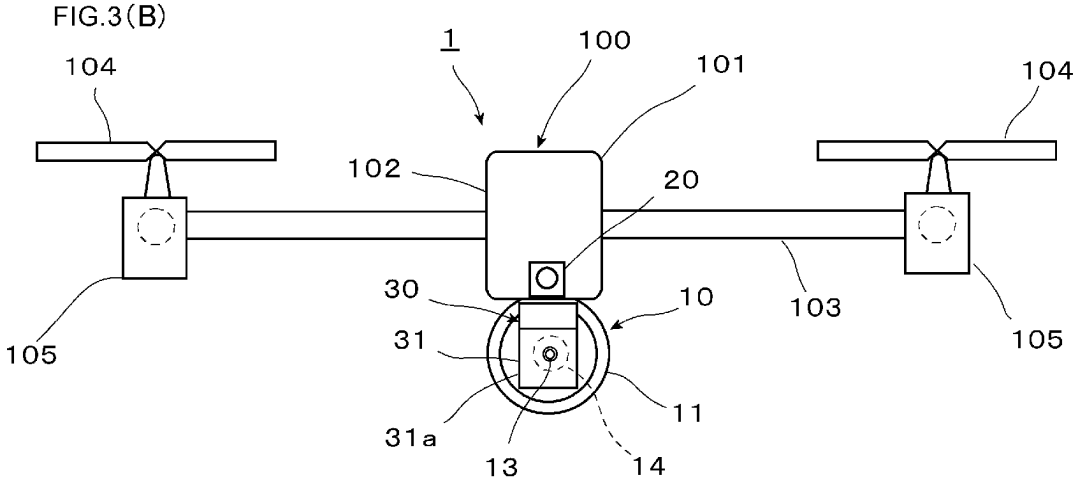


FIG.3(C)

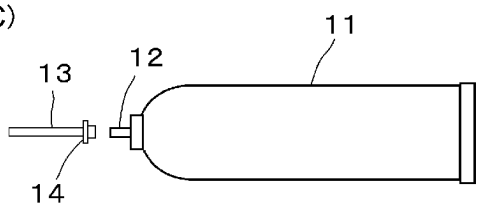


FIG.4(A)

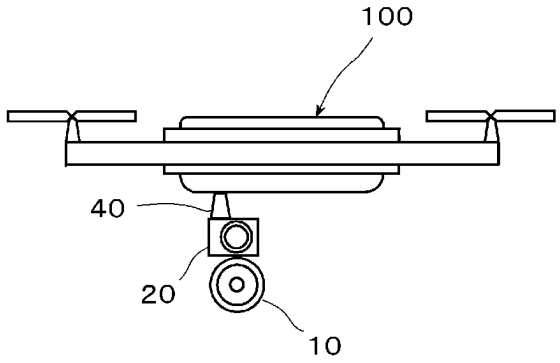


FIG.4(B)

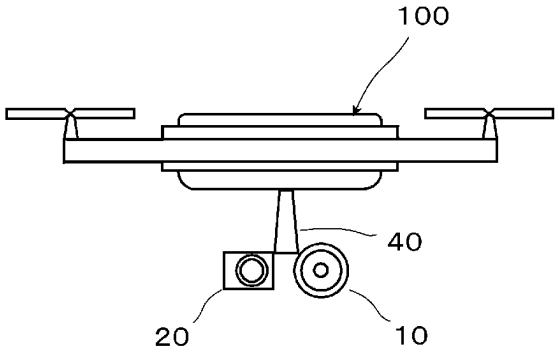


FIG.4(C)

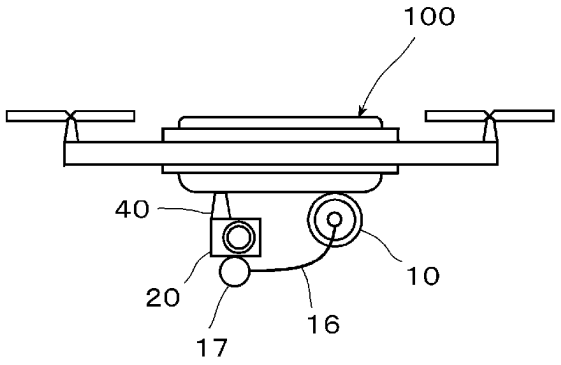


FIG. 5(A)

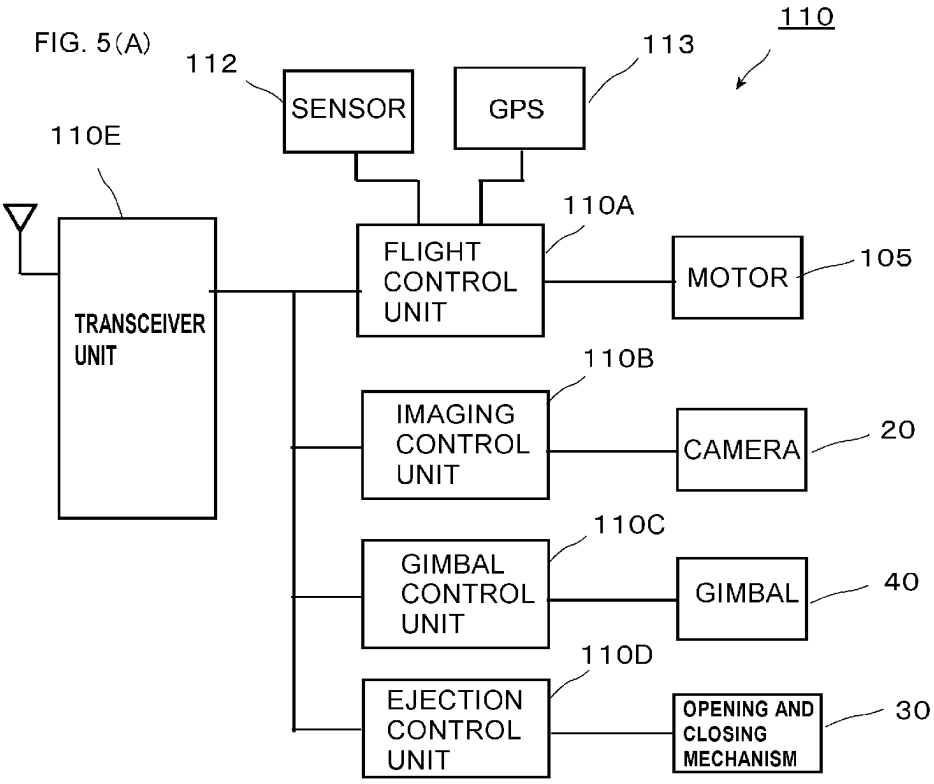

110
112
SENSOR
GPS
113
110E
110A
FLIGHT CONTROL UNIT
MOTOR
105
TRANSCEIVER UNIT
110B
IMAGING CONTROL UNIT
CAMERA
20
110C
GIMBAL CONTROL UNIT
GIMBAL
40
110D
EJECTION CONTROL UNIT
OPENING AND CLOSING MECHANISM
30

FIG. 5(B)

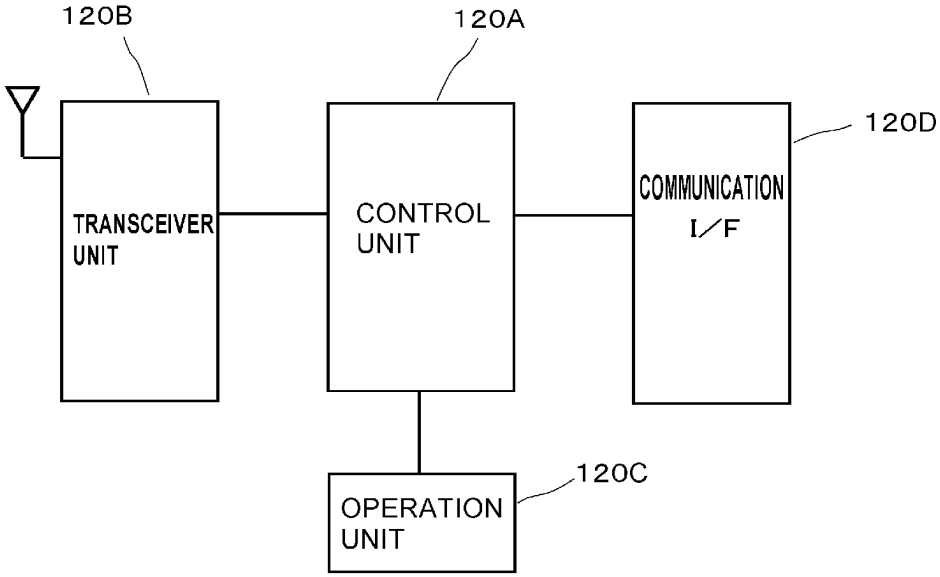

120B
120A
TRANSCEIVER UNIT
CONTROL UNIT
COMMUNICATION I/F
120D
OPERATION UNIT
120C

FIG. 6(A)

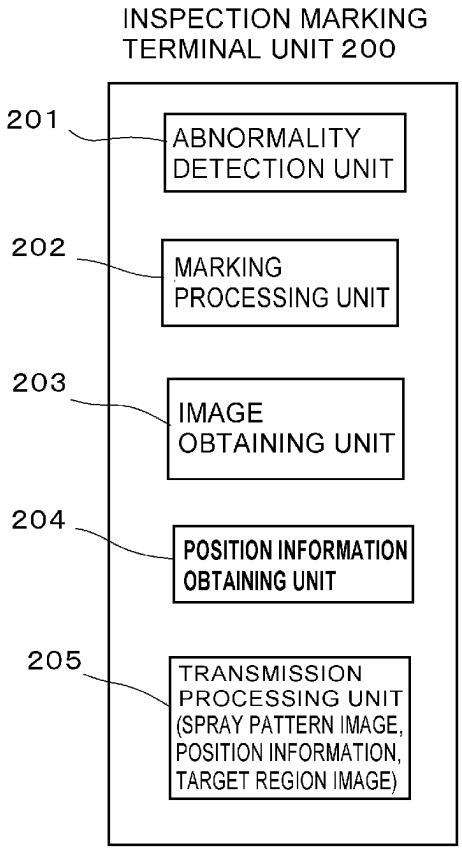

INSPECTION MARKING TERMINAL UNIT 200
201
ABNORMALITY DETECTION UNIT
202
MARKING PROCESSING UNIT
203
IMAGE OBTAINING UNIT
204
POSITION INFORMATION OBTAINING UNIT
205
TRANSMISSION PROCESSING UNIT (SPRAY PATTERN IMAGE, POSITION INFORMATION, TARGET REGION IMAGE)

FIG. 6(B)

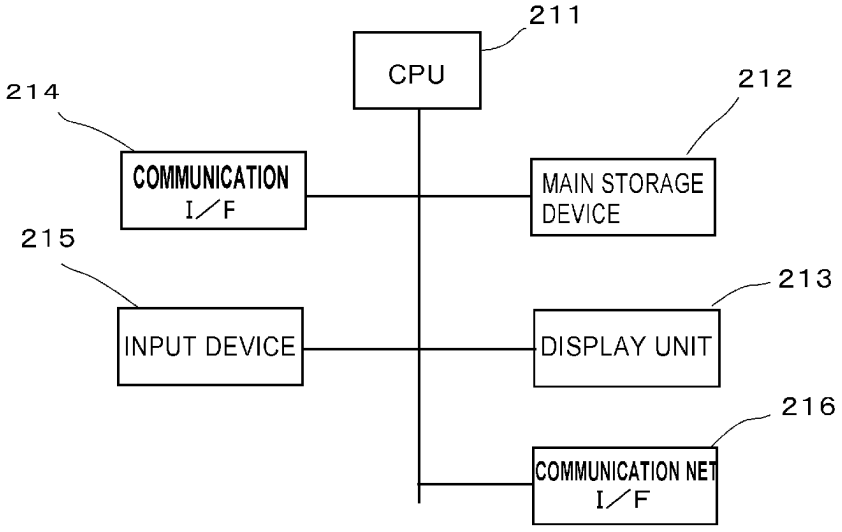

211
CPU
212
214
COMMUNICATION I/F
MAIN STORAGE DEVICE
215
213
INPUT DEVICE
DISPLAY UNIT
216
COMMUNICATION NET I/F

FIG.7(A)

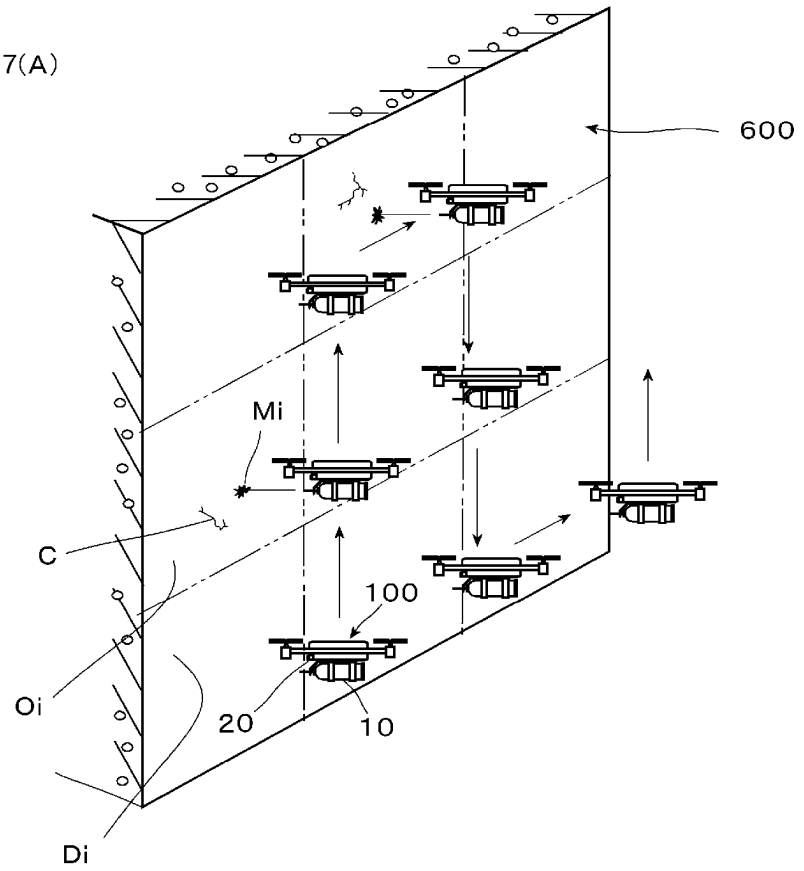


FIG.7(B)

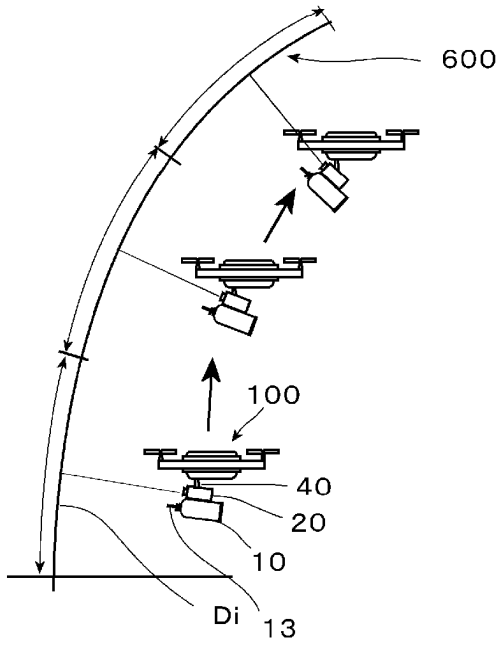


FIG. 8 (A)

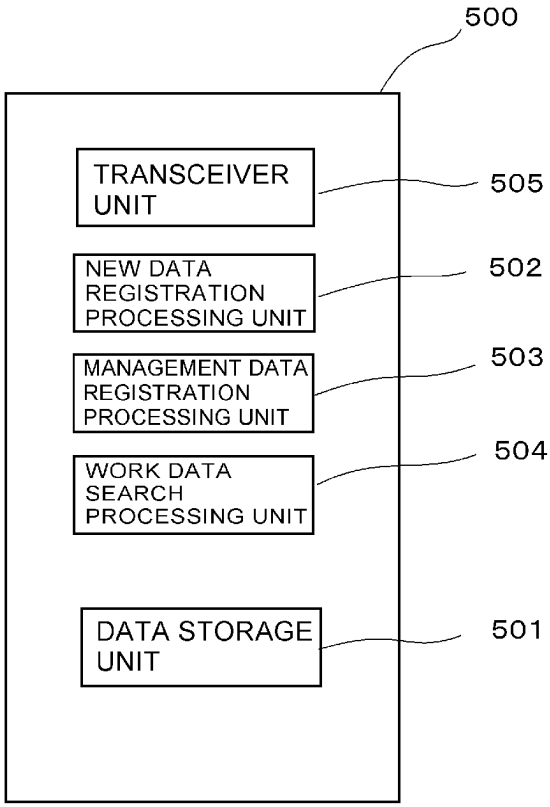

500
TRANSCEIVER UNIT
505
NEW DATA REGISTRATION PROCESSING UNIT
502
MANAGEMENT DATA REGISTRATION PROCESSING UNIT
503
WORK DATA SEARCH PROCESSING UNIT
504
DATA STORAGE UNIT
501

FIG. 8 (B)

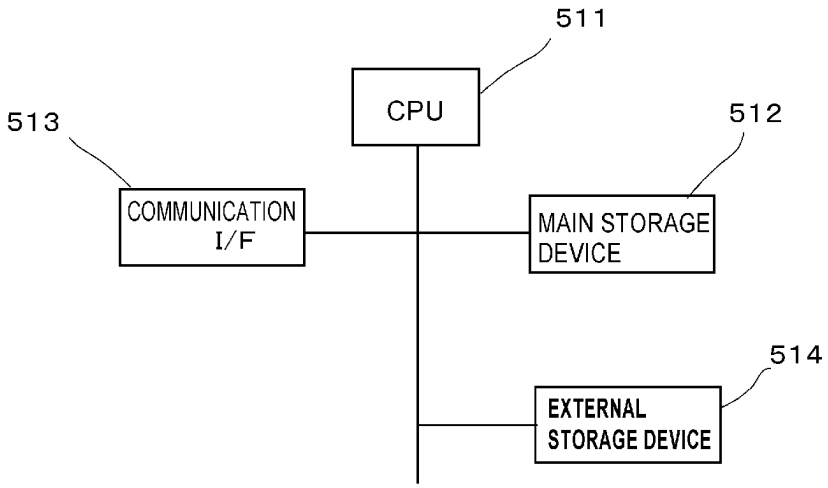

511
CPU
513
512
COMMUNICATION I/F
MAIN STORAGE DEVICE
514
EXTERNAL STORAGE DEVICE

FIG. 9 (A)

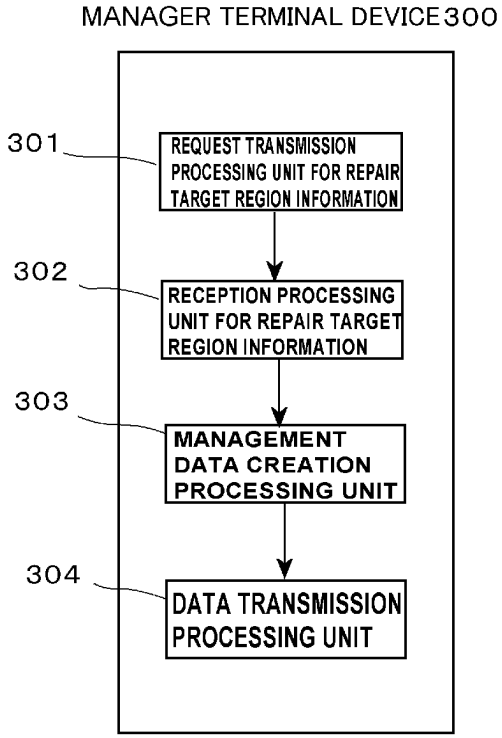

MANAGER TERMINAL DEVICE 300
301
REQUEST TRANSMISSION PROCESSING UNIT FOR REPAIR TARGET REGION INFORMATION
302
RECEPTION PROCESSING UNIT FOR REPAIR TARGET REGION INFORMATION
303
MANAGEMENT DATA CREATION PROCESSING UNIT
304
DATA TRANSMISSION PROCESSING UNIT

FIG. 9 (B)

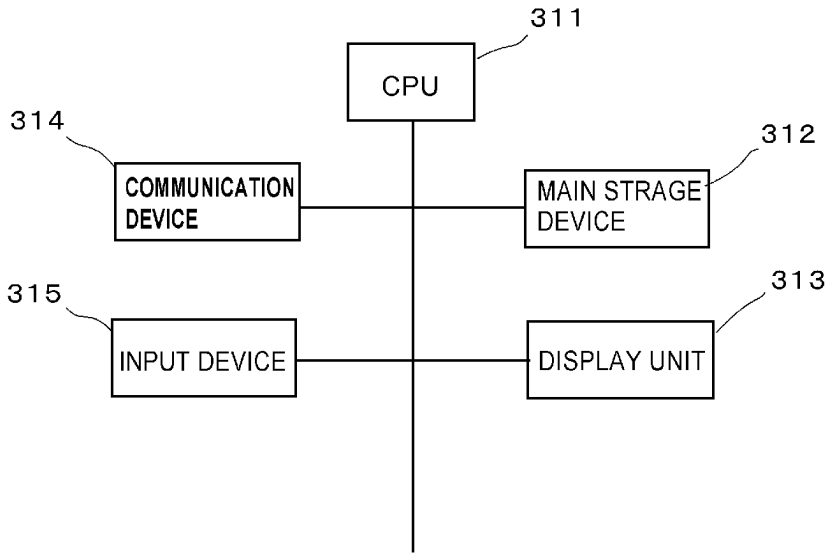

311
CPU
314
COMMUNICATION DEVICE
312
MAIN STRAGE DEVICE
315
INPUT DEVICE
313
DISPLAY UNIT

FIG. 10 (A)

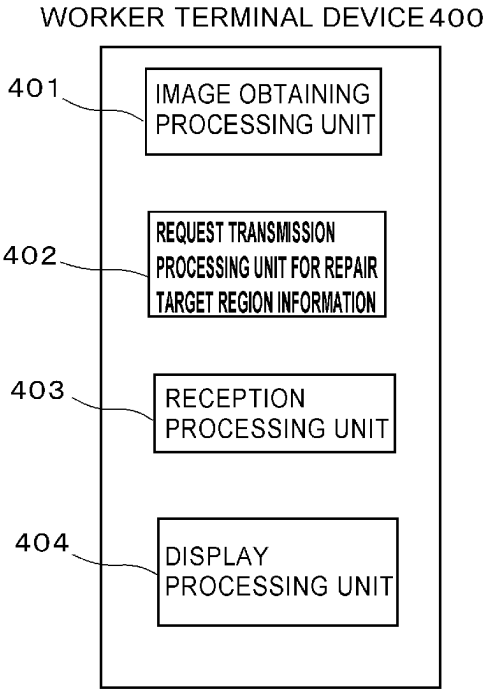


FIG. 10 (B)

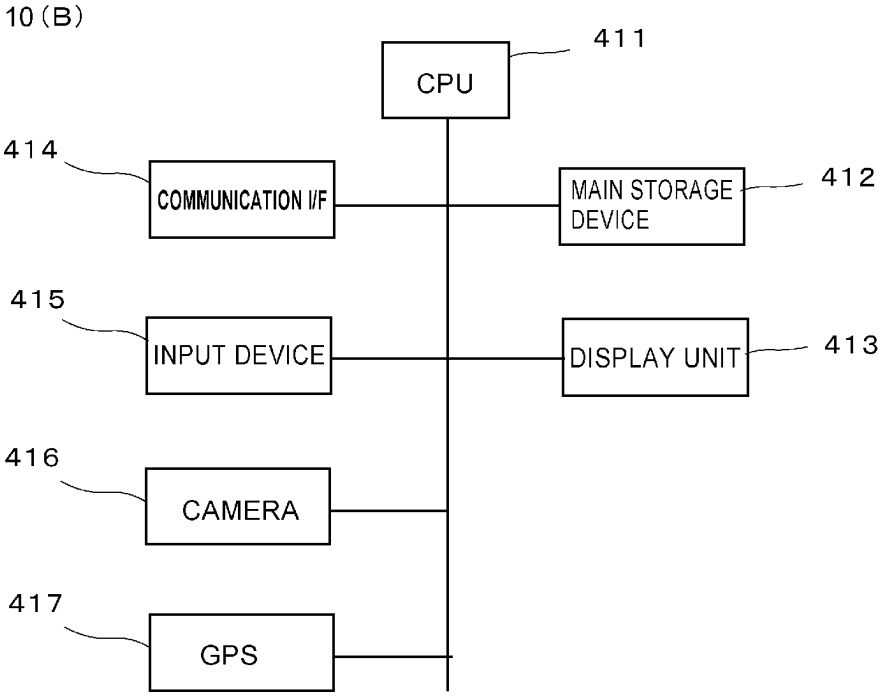


FIG. 11

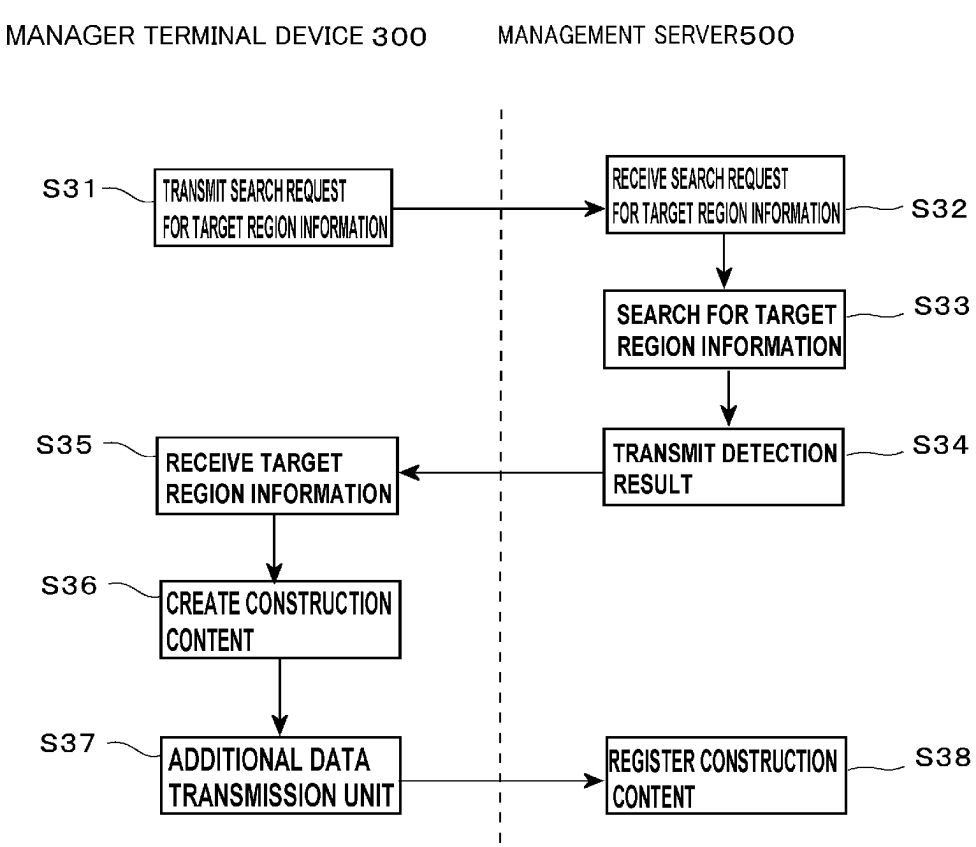
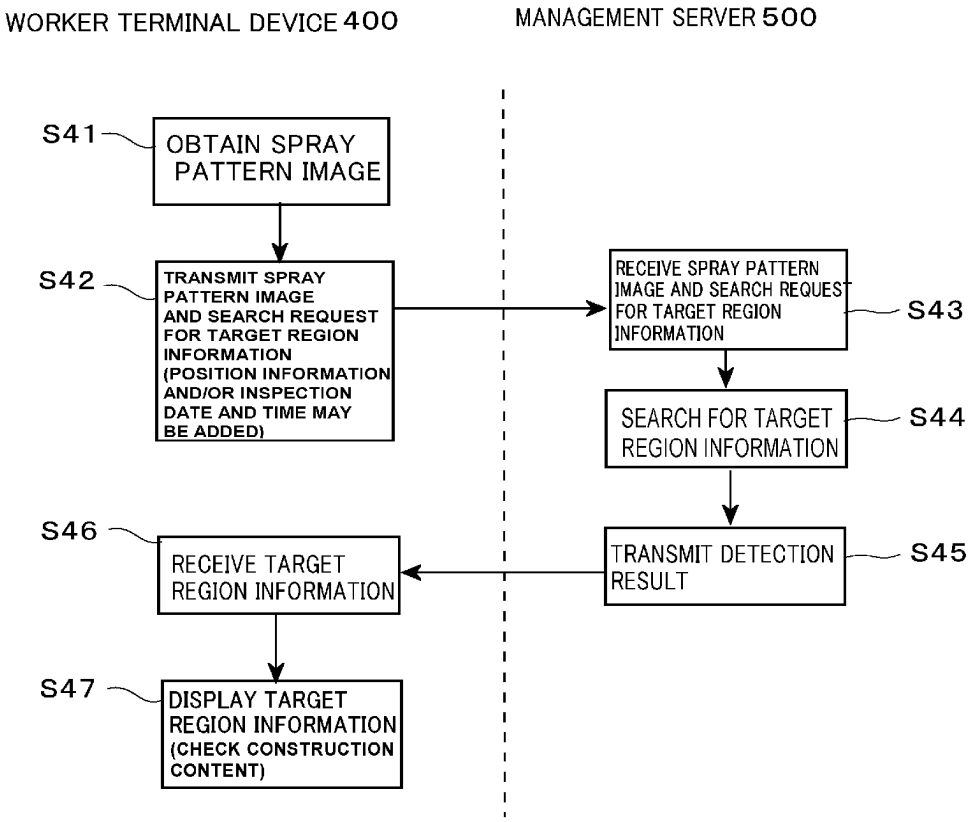

MANAGER TERMINAL DEVICE 300
MANAGEMENT SERVER500
S31
TRANSMIT SEARCH REQUEST FOR TARGET REGION INFORMATION
RECEIVE SEARCH REQUEST FOR TARGET REGION INFORMATION
S32
SEARCH FOR TARGET REGION INFORMATION
S33
TRANSMIT DETECTION RESULT
S34
S35
RECEIVE TARGET REGION INFORMATION
S36
CREATE CONSTRUCTION CONTENT
S37
ADDITIONAL DATA TRANSMISSION UNIT
REGISTER CONSTRUCTION CONTENT
S38

FIG.12


WORKER TERMINAL DEVICE 400
MANAGEMENT SERVER 500
S41
OBTAIN SPRAY PATTERN IMAGE
S42
TRANSMIT SPRAY PATTERN IMAGE AND SEARCH REQUEST FOR TARGET REGION INFORMATION (POSITION INFORMATION AND/OR INSPECTION DATE AND TIME MAY BE ADDED)
RECEIVE SPRAY PATTERN IMAGE AND SEARCH REQUEST FOR TARGET REGION INFORMATION
S43
SEARCH FOR TARGET REGION INFORMATION
S44
TRANSMIT DETECTION RESULT
S45
S46
RECEIVE TARGET REGION INFORMATION
S47
DISPLAY TARGET REGION INFORMATION (CHECK CONSTRUCTION CONTENT)

INFORMATION MANAGEMENT METHOD, IDENTIFICATION INFORMATION IMPARTING APPARATUS, AND INFORMATION MANAGEMENT SYSTEM

TECHNICAL FIELD

The present invention relates to an information management method, an identification information imparting apparatus, and an information management system in which a spray pattern formed by spraying paint on a target object is used as identification information of the target object.

BACKGROUND ART

In recent years, the use of unmanned flying objects (aerial vehicles) such as multicopters has been studied for the inspection of concrete walls of structures or the like such as tunnels, bridges, dams, buildings, etc. (for example, see Patent Literature 1).

However, even if an abnormality is found, the content of repair work is reviewed, and a construction plan for the repair work is made, it is difficult for a worker to identify an abnormal part from position information in the field. Thus, it is conceivable to add identification information such as characters, symbols, bar codes or the like.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Patent Application Laid-Open Publication No. 2017-124691

SUMMARY OF INVENTION

Technical Problem

However, it is difficult for a remotely operated machine, such as a multicopter, to write or digitally print existing characters and/or symbols on a structure as identification information. The reason is that, for example, with a multicopter, it is difficult to get close to a target object for printing or drawing that requires precision.

The inventors of the present invention have focused on the fact that spray patterns formed by spraying paint on target objects are not the same as one another and can identify the target objects like fingerprints, and have come up with an idea of using the spray patterns as identification information.

An object of the present invention is to provide an information management method, an identification information imparting apparatus, and an information management system that use a spray pattern capable of identifying a target object in a simple way.

Solution to Problem

In order to achieve the above object, an information management method of the present invention is characterized by: spraying a liquid material on a part of a target object to form an irregular spray pattern; storing a spray pattern image, which is obtained by photographing and imaging the spray pattern, and information about the target object in association with each other; and managing the information about the target object using the spray pattern image as identification information of the target object.

In addition, an identification information imparting apparatus of the present invention is an identification information imparting apparatus for imparting identification information to a target object, characterized by comprising:

- a liquid material ejection means configured to spray a liquid material onto the target object to form an irregular spray pattern; and
- an imaging means configured to image the spray pattern and record it as a spray pattern image; wherein the spray pattern image is used as identification information of the target object.

The present invention can also be configured as follows.

1. The liquid material ejection means is provided with an aerosol container for ejecting the liquid material by gas pressure in the container.
2. The liquid material ejection means is provided with a spray control means configured to control ejection of the liquid material from the aerosol container.
3. The liquid material is ejected as a jet stream.
4. The liquid material ejection means and the imaging means are mounted on a moving object.

Moreover, another information management method of the present invention is characterized by:

- mounting an imaging means and a liquid material ejection means on a moving object;
- moving the moving object to spray, upon finding a target region on a surface of a target object, a liquid material from the liquid material ejection means to a part of or a vicinity of the target region to form an irregular spray pattern;
- imaging the target region including the spray pattern by the imaging means to obtain image information and to extract a spray pattern image from the image information;
- obtaining position information of the moving object by a position information detection means; and
- storing, in an information storage unit, the spray pattern image and target region information about the target region including the position information and image information of the target region in association with each other thereby to manage the information of the target region.

The present invention can also be configured as follows.

1. The target region of the target object is a region with an abnormality.

Further, an information management system of the present invention is an information management system for managing information about a target region of a target object, characterized by comprising:

- a moving object on which an imaging means and a liquid material ejection means are mounted;
- a spray pattern image obtaining means configured to execute processing of spraying a liquid material from the liquid material ejection means to the target object to form an irregular spray pattern, imaging the target region including the spray pattern by the imaging means to obtain image information, and extracting a spray pattern image from the image information;
- a position information detection means configured to obtain position information of the moving object; and
- a registration means configured to store, in an information storage unit, the spray pattern image and target region information about the target region including the position information and image information of the target region in association with each other.

1. Provision is further made for an information update means configured to update the target region information stored in the information storage means by adding an additional correction thereto.

2. Provision is further made for an information obtaining means configured to obtain the spray pattern image formed in the target region of the target object, and input the spray pattern image thus obtained thereby to obtain corresponding target region information from the information storage means.

3. The target region is a region of the target object in which there is an abnormal part, and provision is further made for an abnormality detection means configured to detect the abnormal part.

Advantageous Effects of Invention

According to the present invention, by using a spray pattern image of a liquid material as identification information, it is possible to manage information about a target object in a simple method of spraying the liquid material onto the target object. In particular, in cases where a moving object is used, even when it is difficult for the moving object to approach the target object, it is possible to easily impart identification information to the target object simply by spraying the liquid material thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a conceptual diagram illustrating an overall configuration of an information management system according to an embodiment of the present invention.

FIG. **2**(A) is a block diagram of the information management system of FIG. **1**, and FIG. **2**(B) is an example of data stored in a data storage unit.

FIG. **3** illustrates an embodiment of an identification information imparting apparatus used in the information management system of FIG. **1**, wherein FIG. **3**(A) is a front view, FIG. **3**(B) is a side view, and FIG. **3**(C) is a view illustrating an aerosol container.

FIG. **4** is a diagram illustrating another configuration example of the identification information imparting apparatus.

FIG. **5**(A) is a control block diagram of a control unit of a flying object, and FIG. **5**(B) is a control block diagram of a transmitter.

FIG. **6**(A) is a functional block diagram of an inspection marking terminal device, and FIG. **6**(B) is a diagram illustrating a configuration example of a computer.

FIG. **7**(A) is a view illustrating an example of an inspection process in the case of a vertical wall, and FIG. **7**(B) is a view illustrating an example of an inspection process in the case of an inclined wall.

FIG. **8**(A) is a functional block diagram of a management server, and FIG. **8**(B) is a diagram illustrating a configuration example of a computer.

FIG. **9**(A) is a functional block diagram of a manager terminal device, and FIG. **9**(B) is a diagram illustrating a configuration example of a computer.

FIG. **10**(A) is a functional block diagram of a worker terminal device, and FIG. **10**(B) is a diagram illustrating a configuration example of a computer.

FIG. **11** is a flowchart illustrating an example of a flow of information between the manager terminal device and a management server in FIG. **9**.

FIG. **12** is a flowchart illustrating an example of a flow of information between the worker terminal device and a management server in FIG. **10**.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

Hereinafter, the present invention will be described in detail on the basis of exemplary embodiments illustrated in the drawings. Dimensions, materials, and shapes of components, relative arrangements thereof, a hardware configuration of an apparatus, a software configuration, a processing flow, and the like described in the following embodiments are to be appropriately changed depending on a target object to which the present invention is applied, a configuration of the apparatus, and various conditions, and are not intended to limit the scope of the present invention to the following embodiments.

First, a conceptual configuration of an information management method and an information management system according to the present invention will be described by using FIG. **1**. This embodiment will be described by taking, as an example, a case where a target object of the present invention is used for repair management of a concrete wall **600** of a structure such as a tunnel, a dam, an expressway, a bridge, a high-rise building or the like.

This information management is divided into three stages that include an inspection marking stage (I) for inspecting and marking an abnormal part of the concrete wall **600**, a registration stage (II) of construction management data for registering a construction content of the abnormal part, and a repair work stage (III) for performing repair work. Hereinafter, each of the stages will be described.

Inspection Marking Stage (I)

In the inspection marking stage (I), a repair target region Oi is marked by spraying a liquid material using an identification information imparting apparatus **1**.

The identification information imparting apparatus **1** includes a liquid material ejection device (liquid material ejection means) **10** and a camera **20** (imaging means), wherein the liquid material ejection device **10** serves to eject the liquid material to the repair target region Oi of the concrete wall **600** as the target object to form an irregular spray pattern. In this embodiment, the liquid material ejection device **10** and the camera **20** are mounted on a flying object **100** which is a moving object, and the concrete wall **600** is photographed and inspected by the camera **20** which is moving with the flying object **100**, and the liquid material such as paint is ejected to a part of or a vicinity of the repair target region Oi, in which an abnormal part C has been found, to form a spray pattern Mi.

The liquid material ejected from the liquid material ejection device **10** collides with the concrete wall **600** and scatters in all directions to spread along a wall surface thereof, or splashes by gravity, air resistance or the like after being ejected and before reaching the wall surface to form the spray pattern Mi. Since the liquid material scatters radially and irregularly due to an impact or the like, an outer periphery m of the spray pattern Mi has an irregular uneven shape. The shape of the outer periphery is not constant, and none of them are the same, and hence, the repair target region Oi can be identified like a fingerprint.

The liquid material is a substance in the form of liquid, gel, cream, or paste, and for example, a paint or the like is used. As the liquid material, a material is suitable which does not fall off due to rain or the like and which can be removed as needed. In addition, a material may be used which is

colorless and transparent in visible light and which can be identified by ultraviolet rays or infrared rays, or in the case of a concrete wall of a tunnel, a luminous material may be used so as to be easily seen or checked by a worker.

The flight of the flying object **100** is remotely controlled by a transmitter **120**, and the liquid material ejection device **10** is controlled by an inspection marking terminal device **200** that constitutes a spray control means. In addition, the operation of the camera **20** is also controlled by the inspection marking terminal device **200**.

The transmitter **120** controls the flight of the flying object **100**, and basically controls the flight, including ascending, descending, turning, horizontal movement, by means of an operation device such as a lever. The exchange of signals between the flying object **100** and the transmitter **120** is communicated by wireless communication.

The inspection marking terminal device **200** controls the flying object **100**, the liquid material ejection device **10**, and the camera **20** via the transmitter **120**, thereby to perform a series of processes of inspection, marking, and photographing. In the figure, there is illustrated a state in which a photographed image is displayed on a display unit **213** of the inspection marking terminal device **200**.

That is, the flying object **100** is caused to fly along the concrete wall **600** while keeping a predetermined distance, so that the surface thereof is photographed by the camera **20** to detect the presence or absence of the abnormal part C such as a crack from an image thus photographed.

Subsequently, the repair target region Oi in which the abnormal part has been found is sprayed with the liquid material by the liquid material ejection device **10**, so that it is marked with the spray pattern Mi.

Then, the repair target region Oi thus marked is photographed by the camera **20**, and a spray pattern image Pi is extracted from the repair target region image Qi thus photographed and imaged, so that the spray pattern image Pi and repair target region information Ri related to the repair target region Oi including the repair target region image Qi are registered and managed in a management server **500** in association with each other. If the information of the repair target region image Qi and the information of the spray pattern image Pi are associated with each other, the photographing of the repair target region Oi may include the repair target region image Qi and the spray pattern image Pi in one image, or these pieces of information may be associated with each other in different images. Further, the repair target region Oi may be a set of a plurality of images. The repair target region information Ri includes, in addition to the repair target region image Qi, position information Si of the repair target region Oi and the like. The position information Si includes, for example, map information such as latitude, longitude, height, etc., the name of a structure provided with a concrete wall as a target object, and the like.

In the repair target region information Ri, the construction content including a repair work content for the abnormal part C is further registered, and the construction content is registered in the management data registration stage (II) which will be described below.

Registration Stage (II) of Construction Management Data

In the registration stage of the construction management data, a construction manager accesses the management server **500** from a manager terminal device **300**, and determines and registers the construction content such as a repair method of the abnormal part such as a crack or the like, by referring to the repair target region image Qi.

Repair Work Stage (III)

In the repair work stage (III), the worker photographs the spray pattern Mi by means of a worker terminal device **400** at the site, transmits the spray pattern image Pi thus photographed to the management server **500**, obtains the construction content of the corresponding repair target region Oi, and performs the repair work based on the construction content.

FIG. **2**(A) illustrates a system configuration of the inspection marking terminal device **200**, the manager terminal device **300**, the worker terminal device **400**, and the management server **500**, which have been mentioned above.

The management server **500** includes a data storage unit (information storage unit) **501** in which the spray pattern image Pi and the repair target region information Ri related to the repair target region are stored in association with each other, and the inspection marking terminal device **200**, the manager terminal device **300**, and the worker terminal device **400** can communicate with one another via a communication network N such as the Internet or the like.

FIG. **2**(B) illustrates an example of data stored in a data storage unit **501**.

That is, the repair target region information Ri is stored in association with the spray pattern image Pi, and the repair target region image Qi including a repair target part, the position information Si, the construction content Ti and the like are included as the repair target region information Ri.

Next, the identification information imparting apparatus used in the inspection marking stage of FIG. **1** will be described in more detail.

FIG. **3** illustrates the identification information imparting apparatus.

This identification information imparting apparatus **1** includes the flying object **100**, and the liquid material ejection device **10** and the camera **20** mounted on the unmanned flying object.

Flying Object **100**

In FIG. **3**, the flying object **100** is a so-called multicopter, and has an airframe **101** that includes a main body portion **102** and a plurality of arm portions **103** extending radially from the main body portion **102**, wherein rotor blades **104** are provided at distal ends of the arm portions **103** via motors **105**, respectively. In the illustrated example, the rotor blades **104** are illustrated at two locations on the left and right, but in the sense that there are a plurality of rotor blades **104**, various known multicopters, such as three (tricopter), four (quadcopter), six (hexacopter), etc., can be applied.

Liquid Material Ejection Device **10**

The liquid material ejection device **10** is configured to include an aerosol container **11** that is mounted on the outside of the airframe **101** of the flying object **100**, an actuator **13** with a nozzle that is connected to a stem **12** provided with a discharge passage of the aerosol container **11**, and an opening and closing mechanism **30** that constitutes an ejection control unit adapted to push the stem **12** through the nozzle-equipped actuator **13** to open the discharge passage.

The aerosol container **11** is a container that ejects a liquid material as a content by the gas pressure of a liquefied gas or a compressed gas filled therein, and an existing aerosol container **11** made of metal or pressure-resistant plastic can be applied thereto. The aerosol container **11** generally sprays the liquid material in the form of a mist from the nozzle by attaching the actuator to the stem **12**, but in the present invention, the purpose is to form a spray pattern, and the liquid material is ejected as a linear jet stream. Although the stem **12** alone can be used to eject the liquid material as a jet

stream, it is necessary to push the stem **12** in, and hence in this embodiment, the actuator **13** with the flanged nozzle is connected thereto, and the stem **12** is pushed in by means of the opening and closing mechanism **30** through a flange **14** of the nozzle-equipped actuator **13**, so that an unillustrated internal valve is opened to eject paint. Here, note that the nozzle is provided with an orifice, which allows a better jet stream to be ejected than in the case of only the stem.

In the illustrated example, the aerosol container **11** is mounted in a state where a central axis of the aerosol container **11** (a central axis of its body) is horizontally oriented by using a space on a lower surface of the airframe **101** of the flying object **100**. A mounting device **50** is provided on the lower surface of the airframe **101**, so that the aerosol container is mounted on the airframe **101** through the mounting device **50**. The mounting device **50** shall be of a structure that can be attached to the airframe, and shall be firmly fixed by bolts or other screw fastening, band fastening, adhesive fastening, etc. The flying object **100** is detachably mounted on the mounting device **50** by a holding member **51** such as a clamper or the like.

The camera **20** is mounted on the front side of the airframe **101** so as to face forward with its photographing direction (optical axis direction of the lens) aligned with the direction of ejection by the aerosol container **11**.

As the form of the propellant and the content of the aerosol container **11**, an isolated type is used in which the liquid material is contained in an inner bag and the propellant is contained between the outer periphery of the inner bag and the inner periphery of the container body. In the case of the isolated type, ejection can be made from the aerosol container **11** even when the aerosol container **11** is in a horizontal orientation (the stem is positioned horizontally) or a downward orientation (the stem is positioned downward).

However, the present invention is not limited to the isolated type, and a two-phase type or three-phase type container with a dip tube can be applied when the posture of the aerosol container **11** at the time of liquid ejection is used with the stem **12** facing upward, and a two-phase type or three-phase type container having no dip tube can be applied when the posture of the aerosol container **11** is used with the stem **12** facing downward.

Here, note that liquefied gases such as general hydrocarbons (liquefied petroleum gas) (LPG), dimethyl ether (DME), and fluorinated hydrocarbons (HFO-1234ze), as well as compressed gases such as carbon dioxide (CO_2), nitrogen (N_2), and nitrous oxide (N_2O) can be used as propellants, but non-flammable fluorinated hydrocarbons, carbon dioxide, nitrogen, nitrous oxide, etc., are suitable, and nitrogen is particularly suitable, considering its environmental impact.

Opening and Closing Mechanism **30**

The opening and closing mechanism **30** includes a pressing member **31** with an engaging portion **31***a* that engages with the flange **14** of the nozzle-equipped actuator **13**, and a driving unit **32** which is a driving means, such as a solenoid, a linear motor or the like, that linearly drives the pressing member **31**, wherein the pressing member **31** is driven in the axial direction of the aerosol container by means of the driving unit **32**, whereby the stem **12** is driven in the direction of being pushed into the container via the pressing member **31** and the nozzle-equipped actuator **13**. The drive unit **32** may be any mechanism that drives in a linear direction, and may linearly drive directly by a linear motor, a solenoid or the like, or may linearly drive via a motion conversion mechanism, such as a cam, a screw feed mechanism or the like, that converts the rotational motion of a rotary motor into a linear direction.

Other Mounting Examples of Liquid Material Ejection Device **10** and Camera **20**

FIG. **4** illustrates an example in which the liquid material ejection device **10** and the camera **20** are mounted on the flying object **100** via a gimbal **40**.

The gimbal **40** is a pedestal having degrees of freedom of rotation about three mutually orthogonal axes, and detects an inclination of each rotation axis by a sensor and corrects the inclination of the rotation axis by a motor, and various known devices can be applied to the gimbal **40**. By using the gimbal **40**, the camera **20** and the liquid material ejection device **10** can be stabilized, and the camera **20** and the liquid material ejection device **10** can be tilted.

FIG. **4**(A) illustrates an example in which the liquid material ejection device **10** is attached to the camera **20** mounted via a gimbal **40**. The liquid material ejection device **10** is held by utilizing a frame of the gimbal **40** that holds the camera **20**. In this way, the camera **20** and the liquid material ejection device **10** are moved in synchronization with each other by means of the gimbal **40**.

FIG. **4**(B) illustrates an example in which the liquid material ejection device **10** and the camera **20** are attached to the gimbal **40** in a parallel state. In this case, too, the camera **20** and the liquid material ejection device **10** are moved in synchronization with each other by means of the gimbal **40**.

In FIG. **4**(C), the liquid material ejection device **10** is mounted on the lower surface of the airframe **101** side by side with the camera **20** to balance the center of gravity, and a nozzle **17** is connected to an ejection port of the liquid material ejection device **10** via a flexible extension tube **16**, so that the nozzle **17** is attached to the camera **20** held by the gimbal **40**. In this case, the nozzle **17** is moved in synchronization with the camera **20** by means of the gimbal **40**.

Control Unit of Flying Object

FIG. **5**(A) is a control block diagram of a control unit provided in the flying object **100**.

That is, the control unit **110** of the flying object includes a transceiver **110**E that communicates with the transmitter **120**, a flight control unit **110**A that controls the flight of the flying object **100**, a camera control unit **110**B that controls the operation of the camera **20**, a gimbal control unit **110**C that controls the gimbal **40** in the case where the gimbal **40** is provided, and an ejection control unit **110**D that controls the ejection timing and the ejection period of time of the opening and closing mechanism **30**.

The flight control unit **110**A calculates a control signal to the motor **105** of each of the rotor blades **104** based on detection information from sensors **112** such as gyro sensors, acceleration sensors, geomagnetic sensors, range sensors, etc., position information from a GPS **113**, command signals from the transmitter **120**, or command signals transmitted from inspection marking terminal device **200** via the transmitter **120**, thereby to control the flight of the flying object **100**. In the figure, only one motor **105** is described for simplification, but a plurality of motors are provided.

The camera control unit **110**B executes a photographing or imaging operation by the camera **20** based on the command signals transmitted from the inspection marking terminal device **200** via the transmitter **120**.

The ejection control unit **110**D outputs ejection and stop signals to the driving unit **32** of the opening and closing mechanism **30** based on the command signals transmitted from the inspection marking terminal device **200** via the

transmitter **120**, thereby to control the ejection operation of the liquid material ejection device **10**.

Each control unit is described as a functional block that executes a respective process, and although not particularly described, a computer can execute control processes of flight control, camera control, and ejection operation by performing arithmetic processing by a CPU which is a hardware resource provided in the control unit **110**, on the basis of a program stored in a memory unit.

FIG. **5**(B) is a control block diagram of the transmitter **120**.

That is, it has a control unit **120**A, a transceiver unit **120**B that transmits signals to the transceiver unit **110**E of the control unit **110** of the flying object via an antenna, an operation unit **120**C such as a stick or the like, and a communication interface **120**D (hereinafter, I/F) that communicates with the inspection marking terminal device **200**.

Inspection Marking Terminal Device **200**

FIG. **6**(A) is a functional block diagram of the inspection marking terminal device.

That is, it includes an abnormality detection unit (abnormality detection means) **201** for an inspection target region, a marking processing unit **202** that operates the liquid material ejection device **10** to perform marking processing, an image obtaining unit **203** that obtains an image of the target region marked, a position information obtaining unit (position information detection means) **204** that obtains position information, and a transmission processing unit **205** that transmits the spray pattern image, the position information, and the target region image to the management server **500** in association with each other.

In the image obtaining unit **203**, the spray pattern image is extracted from the image of the target region.

The position information obtaining unit **204** obtains information about the location of the concrete wall **600** and position information about a spraying position.

This inspection marking terminal device **200** constitutes a spray pattern image obtaining means of the information management system of the present invention.

FIG. **6**(B) illustrates the configuration of a computer that constitutes the inspection marking terminal device **200**, and FIG. **1** illustrates an information terminal device of a general tablet type.

The computer has a general configuration, and includes a CPU (Central Processing Unit) **211**, a main storage device **212** composed of a ROM and a RAM, a display unit **213** such as for example a touch panel type LCD or the like, a communication I/F **214** for connecting to the transmitter **120**, an input device **215** for inputting information, and a communication network I/F **216** for accessing the management server **500** via a relay station and a communication network such as the Internet.

The processes of the abnormality detection unit **201**, the marking processing unit **202**, the image obtaining unit **203**, the position information obtaining unit **204**, and the transmission processing unit **205** are performed by executing a program stored in the main storage device **212** or a program stored in the management server **500** via the communication network I/F **216**.

Note that the inspection marking terminal device **200** can use a camera controller that is provided separately from the transmitter **120** and includes an operation unit for controlling the operation of the camera **20**, or can be provided integrally with the transmitter, and any combination of devices can be used.

FIG. **7** illustrates an example of an inspection procedure of the concrete wall.

FIG. **7**(A) illustrates a vertical wall, in which the concrete wall **600** is divided into a plurality of inspection regions Di in a grid pattern in the vertical and horizontal directions, and inspection is performed by repeating ascent and descent for each column. Marking Processing Process

When the inspection is started, the processing of the abnormality detection unit **201** of the inspection marking terminal device **200** is executed. That is, the CPU **211** reads out an inspection processing program from the main storage device **212** to execute a series of inspection processing procedures.

When inspection processing is executed, the flying object **100** flies to a first inspection region Di and enters a hovering state, so that it operates the camera **20** to photograph the inspection region Di thereby to obtain an image for inspection. The image from the camera **20** is received by the transmitter **120** through wireless communication between the flying object **100** and the transmitter **120**, and is transmitted from the transmitter **120** to the inspection marking terminal device **200** through the communication I/F **214**.

Then, the presence or absence of an abnormal part is detected from the inspection image thus obtained. The abnormal part may be detected, for example, by recognizing the width of a crack and determining that the crack is abnormal when the width is equal to or larger than a predetermined width, or by using a determination means that uses Al.

When there is no abnormal part, the inspection region is moved to the next inspection region.

When there is an abnormal part, the processing of the marking processing unit **202** is executed, so that a liquid material ejection command is transmitted to activate the liquid material ejection device **10** to spray the liquid material on the wall surface of the inspection region Di thereby to form the spray pattern Mi.

When the marking is completed, the processing of the image obtaining unit **203** is executed, and a photographing command signal is transmitted so that the camera **20** is activated to obtain an image of the target region to which the spray pattern Mi is attached. The image thus photographed is transmitted to the inspection marking terminal device **200** via the transmitter **120** in the same manner as the inspection image.

Subsequently, the processing of the transmission processing unit **205** is executed, so that the spray pattern image Pi is extracted from the image of the inspection region Di obtained, and is transmitted to the management server **500** in association with the image and the position information of the inspection region Di to which the spray pattern is attached, and the inspection region is then moved to the next inspection region.

When the liquid material is ejected, a reaction force in a direction opposite to the direction of the ejection of the liquid material acts on the flying object **100** due to the momentum of the ejected liquid material, but since the amount of liquid required to form the spray pattern is small, this does not have any effect.

In the Case of the Concrete Wall **600** being an Inclined Surface

FIG. **7**(B) illustrates an example of an inspection procedure in the case of an inclined wall such as a tunnel or the like.

In this case, by using the flying object **100** with the camera **20** and the liquid material ejection device **10** mounted thereon via the gimbal **40**, as illustrated in FIG. **4**, the camera **20** and the liquid material ejection device **10** can be tilted in accordance with the inclination of the wall surface.

For example, if the flying object **100** is caused to rise while maintaining a certain distance from the wall surface by using a distance sensor, a flight trajectory thereof can be known, and if an optical axis of the camera **20** is aligned perpendicular to the flight trajectory by means of the gimbal **40**, the directions of the camera **20** and the nozzle-equipped actuator **13** of the liquid material ejection device **10** can be oriented perpendicular to the wall surface.

Note that in FIG. **7**, each inspection region Di is assumed to be photographed or imaged in a state of hovering at a certain position to detect an abnormal part, but it is also possible for the flying object to fly continuously and stop at the time of detecting an abnormal part to perform imaging and marking processing.

Management Server **500**

FIG. **8**(A) illustrates a functional block diagram of the management server **500**.

That is, it includes the data storage unit **501**, a new data registration processing unit (registration means) **502**, a management data registration processing unit **503**, a work data search processing unit **504**, and a transceiver unit **505**.

The data storage unit **501** stores the spray pattern image Pi, which is image information of the irregular spray pattern Mi formed by spraying the liquid material onto the repair target region, and the repair target region information such as the repair target region image Qi, which is image information of the corresponding repair target region Oi, position information or the like, in association with each other.

The new data registration processing unit **502** registers, in the data storage unit **501**, the spray pattern image Pi, the repair target region image Qi, the position information, and the like transmitted from the inspection marking terminal device **200** in association with each other.

In response to a data request transmitted from the manager terminal device **300**, the management data registration processing unit **503** obtains the corresponding spray pattern image Pi and repair target region information from the data storage unit **501**, and transmits them from the transceiver unit **505** to the manager terminal device **300**.

In response to a data request from the worker terminal device **400**, the work data search processing unit **504** searches the data storage unit **501** for information of the repair target region corresponding to the spray pattern image Pi, obtains corresponding repair target region information, and transmits it to the worker terminal device **400**.

FIG. **8**(B) illustrates an example of a hardware configuration of a computer that implements the management server **500**.

That is, a CPU **511**, a main storage device **512** composed of a ROM and a RAM, a net communication I/F **513**, an external storage device **514** such as a hard disk or the like, etc., are provided.

The external storage device **514** is used as the data storage unit **501** illustrated in FIG. **8**(A). In addition, each processing unit is operated and processed by the CPU **511** based on a program stored in the main storage device **512**, which is a hardware resource, to realize each function. That is, the processes of the new data registration processing unit **502**, the management data registration processing unit **503**, and the work data search processing unit **504** are performed by executing the program stored in the main storage device **512**.

Next, the registration stage of the construction management data will be described.

FIG. **9**(A) is a functional block diagram of the manager terminal device **300**.

That is, the manager terminal device **300** includes a request transmission processing unit **301** that transmits a search request for repair target region information to the management server **500**, a reception processing unit **302** that receives the repair target region information from the management server **500**, a management data creation processing unit **303** that creates management data such as a construction content or the like, and a data transmission processing unit **304** that transmits the created data.

This manager terminal device **300** constitutes an information updating means for updating data by adding and correcting target object information stored in the data storage unit **501**.

FIG. **9**(B) illustrates a hardware configuration of a computer that realizes the manager terminal device **300**.

That is, a CPU **311**, a main storage device **312** composed of a ROM and a RAM, a display unit **313** such as an LCD or the like, a net communication I/F **314** for accessing the management server **500**, an input device **315** for inputting information, and the like are provided.

Each processing unit illustrated in FIG. **9**(A) is operated and processed by the CPU **311** based on a program stored in the main storage device **312**, which is a hardware resource, to realize each function. That is, the processes of the request transmission processing unit **301**, the reception processing unit **302**, the management data creation processing unit **303**, and the data transmission processing unit **304** are performed by executing the program stored in the main storage device **312**.

FIG. **11** illustrates a processing procedure between the manager terminal device **300** and the management server **500**.

That is, the manager accesses the management server **500** from the manager terminal device **300**, and transmits a search request for target region information for which a construction content is to be registered (S**31**). The search request can identify the repair target region by identifying, for example, an inspection place or location such as a tunnel, a dam, a bridge or the like, or an inspection date or the like.

In the management server **500**, upon receiving the search request at the transceiver unit **505** (S**32**), the processing of the management data registration processing unit **503** is executed to search the data storage unit **501** for repair target region information (S**33**), and the repair target region information thus searched or extracted is transmitted to the manager terminal device **300** (S**34**). At the side of the manager terminal device **300**, upon receiving the repair target region information (S**35**), the repair target region information is displayed on the display unit **313**. The manager checks an abnormal part such as a crack or the like from a repair target region image displayed, and inputs an appropriate construction content as additional information to create additional data (S**36**). When the additional data is created, the additional data is transmitted to the management server **500** (S**37**), and is registered in the information storage unit **501** in the management server **500** (S**38**).

Stage of Repair Work

The worker carries the worker terminal device **400** provided with a camera **416**, and transmits to the management server **500** the spray pattern image Pi obtained by photographing and imaging the spray pattern Mi attached to the concrete wall **600** at the work site by the camera **416**, and requests corresponding target region information. Then, the target region information transmitted from the management server **500** in response to the request is received and displayed on a display unit **413**.

FIG. **10**(A) is a functional block diagram of the worker terminal device **400**.

That is, the worker terminal device **400** includes an image obtaining processing unit **401** that obtains a spray pattern image, a request transmission processing unit **402** that transmits a search request for corresponding repair target region information with the spray pattern image attached thereto to the management server **500**, a reception processing unit **403** that receives the repair target region information from the management server **500**, and a display processing unit **404** that displays the repair target region information on the display unit **413**.

This worker terminal device **400** constitutes an information obtaining means that obtains corresponding target object information from the data storage unit of the information management system of the present invention.

FIG. **10**(B) illustrates a hardware configuration of a computer that realizes the worker terminal device **400**.

That is, a CPU **411**, a main storage device **412** composed of a ROM and a RAM, the display unit **413** such as an LCD or the like, a net communication I/F **414** for accessing the management server **500**, an input device **415** for inputting information, the camera **416**, and a GPS **417** are provided.

The processes of the image obtaining processing unit **401**, the request transmission processing unit **402**, the reception processing unit **403**, and the display processing unit **404**, which are illustrated in FIG. **10**(A), are performed by executing a program stored in the main storage device **212**.

FIG. **12** illustrates a flow of information between the worker terminal device **400** and the management server **500**.

That is, when finding the spray pattern Mi at the work site, the worker photographs the spray pattern with the camera **416** to obtain a spray pattern image (S**41**), accesses the management server **500**, and transmits a search request for repair target region information with the photographed spray pattern image attached thereto. In addition, position information obtained by the GPS **417**, inspection date and time, and the like may be added to the search request (S**42**).

In the management server **500**, upon receiving the search request at the transceiver unit **505** (S**43**), a program for the work data search processing unit **504** is executed to search the data storage unit **501** for repair target region information (S**44**), and the repair target region information thus searched or extracted is transmitted to the worker terminal device **400** (S**45**). At the side of the worker terminal device **400**, when the target region information is received (S**46**), repair target region information including a construction content is displayed on the display unit **413** (S**47**). The worker can check or confirm the site by looking at the spray pattern image and the repair target region image displayed on the display unit **413** as well as the spray pattern and the abnormal part of the wall surface at the site, and perform the repair work according to the construction content displayed.

In this way, the worker can obtain information including the construction content from the management server **500** by photographing the spray pattern Mi with the camera **416** and inquiring to the management server **500**, which simplifies the confirmation work and eliminates the need for complicated work of carrying documents describing the construction content.

Other Embodiments

Here, note that in the above-described embodiment, the abnormality detection means is provided as the target region detection unit, but the abnormality detection means is not necessarily required. For example, an inspector may visually monitor images taken from the flying object, and execute marking processing if a defective part is found.

Also, without detecting a specific target region, all target regions may be marked and used as identification information of the target regions.

In addition, in the above-described embodiment, the aerosol container is mounted on the airframe in an exposed state, but it may be mounted on the flying object in a state of being housed in a sleeve which is a housing container. Moreover, in the above-described embodiment, an example has been described in which the aerosol container **11** is mounted outside the airframe **101**, but the aerosol container **11** may be configured such that it is placed inside the airframe **101**, with the nozzle **17** being connected thereto via the extension tube **16**, as illustrated in FIG. **4**(C).

Further, in the above-described embodiment, an example has also been described in which a multicopter is used as the flying object on which the liquid material ejection device is mounted, but an unmanned aerial vehicle using propellers may be used, instead of the flying object using rotor blades (rotors). Furthermore, the present invention is not limited to unmanned flying objects, but can also be applied to unmanned or manned moving objects that travel on a road surface.

Also, in the above-described embodiment, a concrete wall has been described as an example of a target of the present invention, but the invention is not limited to such a concrete wall, and can be widely used as identification information of various target objects such as glass of buildings, panels of solar power generation facilities, trees, etc.

DESCRIPTION OF REFERENCE SIGNS

10 liquid material ejection device (liquid material ejection means),
11 aerosol container,
12 stem, **13** actuator with nozzle, **14** flange,
16 extension tube, **17** nozzle,
30 opening and closing mechanism, **31** pressing member, **31***a* engaging portion, **32** driving unit,
20 camera,
40 gimbal,
50 mounting device, **51** holding member,
100 flying object,
101 airframe, **102** body portion, **103** arm portions,
104 rotor blades, **105** motors,
110 control unit,
110A flight control unit, **1106** camera control unit,
110C gimbal control unit,
110D ejection control unit (spray control means),
110E transceiver unit, **112** sensors, **113** GPS,
120 transmitter, **120**A control unit, **1206** transceiver unit,
120C operation unit, **120**D communication interface,
200 inspection marking terminal device,
201 abnormality detection unit (abnormality detection means), **202** marking processing unit, **203** image obtaining unit, **204** position information obtaining unit (position information detection means), **205** transmission processing unit,
211 CPU, **212** main storage device, **213** display unit,
214 communication I/F, **215** input device, **216** communication network I/F,
300 manager terminal device,
301 request transmission processing unit, **302** reception processing unit, **303** management data creation processing unit, **304** data transmission processing unit,

311 CPU, **312** main storage device, **313** display unit,
314 net communication I/F, **315** input device,
400 worker terminal device,
401 image obtaining processing unit, **402** request transmission processing unit, **403** reception processing unit, **404** display processing unit,
411 CPU, **412** main storage device, **413** display unit, **414** net communication I/F, **415** input device, **416** camera, **417** GPS
500 management server,
501 data storage unit (information storage means), **502** new data registration processing unit (registration means), **503** management data registration processing unit, **504** work data search processing unit, **505** transceiver unit,
511 CPU, **512** main storage device, **513** net communication I/F,
514 external storage device,
600 concrete wall (target object),
I first stage, II second stage, Ill third stage,
Mi spray pattern, m outer periphery,
Oi repair target region (target object),
Pi spray pattern image,
Qi repair target region image,
Ri repair target region information,
Si position information,
Ti construction content,
N communication network
Di inspection region

The invention claimed is:

1. An information management method comprising:

spraying a visible liquid material on a part of a target object with an abnormal part to form a spray pattern comprising an irregularly-shaped outer periphery, wherein the spray pattern with an irregular shape of an outer periphery is formed by the visible liquid material being ejected and collided with the target object and scattered, or splashing after being ejected and before reaching the target object;

storing a spray pattern image, which is obtained by photographing and imaging the spray pattern, and information about the target object in association with each other; and

managing the information about the target object by using the irregular shape of the irregularly-shaped outer periphery of the spray pattern image as identification information of the target object.

2. The information management method according to claim **1**, wherein managing the information comprises:

in response to a data request transmitted from a manager terminal device, transmitting the spray pattern image and the information about the target object associated with each other to the manager terminal device, and

in response to a data request from a worker terminal device to obtain the information about the target object that is associated with the spray pattern image, transmitting the information about the target object to the worker terminal device.

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