

[DESCRIPTION]

[TITLE OF INVENTION]

PATROLLING ROBOT, INFORMATION COLLECTION SYSTEM, REMOTE
IMAGE DISPLAY SYSTEM, INFORMATION COLLECTION METHOD, REMOTE
IMAGE DISPLAY METHOD, FIELD ASSISTANCE DEVICE, AND FIELD
ASSISTANCE DEVICE SYSTEM

[Technical Field]

[0001]

The present invention relates to a patrolling robot,
an information collection system, a remote image display
system, an information collection method, a remote image
display method, a field assistance device, and a field
assistance device system.

This application claims priority on Japanese Patent
Application No. 2020-101087 and Japanese Patent Application
No. 2020-101088 filed June 10, 2020, and Japanese Patent
Application No. 2021-009884 filed January 25, 2021, the
contents of the Japanese Patent Applications are
incorporated herewith.

[Background Art]

[0002]

In recent years, a technique for collecting
measurement information indicating the state of the
surrounding environment of a construction field has been
known (for example, see Patent Document 1). In the above-

mentioned conventional technique, the measurement information measured by a sensor device placed at a predetermined place on a construction field is collected by using a mobile terminal carried by a person involved in construction work who moves around in the construction field.

[Citation List]

[Patent Document]

[0003]

[Patent Document 1]

Japanese Unexamined Patent Application, First
Publication No. 2014-146169

[Summary of Invention]

[Technical Problem]

[0004]

However, conventionally, the staff patrols around the construction field to collect management information such as progress management, craftsman management, quality control, safety management and the like. By the above-mentioned technique, a part of the measurement information measured by a sensor device placed at the predetermined place of the construction field was collected. However, with the above-mentioned technology, it is difficult to integrally collect and manage various information used at the construction field because it depends on the movement

of the staff or the like patrolling around the construction field, and there is a case in which the collection efficiency is poor.

[0005]

The present disclosure has been made in view of such circumstances, and an object thereof is to provide a patrolling robot, an information collection system, a remote image display system, an information collection method, and a remote image display method capable of efficiently collecting appropriate information at a construction field, and to provide a field assistance device and a field assistance system capable of integrally collecting and managing various information used at the construction field.

[Solution to Problem]

[0006]

An aspect of the present disclosure is a patrolling robot including a driving unit being autonomously moveable in a construction field; an imaging unit being able to capture an image; and a patrol processing unit performs an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding environment of the construction field, and in a case in

which the node is reached, makes the imaging unit to capture the image and acquire the state information at least including the image.

[0007]

An aspect of the present disclosure is an information collection system including a patrolling robot having a driving unit being autonomously moveable in a construction field; an imaging unit being able to capture an image; and a patrol processing unit performs an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding environment of the construction field, and in a case in which the node is reached, makes the imaging unit to capture the image and acquire the state information at least including the image, and an information collection device collects and stores the state information acquired by the patrolling robot.

[0008]

An aspect of the present invention is remote image display system including a patrolling robot; and a head-mounted display device, wherein the patrolling robot includes a driving unit being autonomously moveable in a construction field; an imaging unit being able to capture an image; a patrol processing unit performs an autonomous

movement by the driving unit based on map information of the construction field and a predetermined patrol route, and makes the imaging unit to capture the image, a visual-field-angle information receiving portion receives visual-field-angle information transmitted from the head-mounted display device; an extraction unit extracts an image corresponding to the visual-field-angle in the spherical image that is captured in the construction field by the imaging unit; and an image transmission unit transmits the extracted extraction image to the head-mounted display device, wherein the head-mounted display device is mountable on the head of a user, and the head-mounted display device includes an orientation detection unit detects an orientation of the head; a visual-field-angle calculation unit calculates visual-field-angle information indicating a direction of visual field corresponding to the detected orientation; a transmission unit transmits the calculated visual-field-angle information to the patrolling robot; an image receiving unit receives the extraction image; and a display displays the received extraction image.

[0009]

An aspect of the present disclosure is an information collection method including a patrolling processing step by a patrolling robot including a driving unit being

autonomously moveable in a construction field and an imaging unit being able to capture an image to perform an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding environment of the construction field, and in a case in which the node is reached, make the imaging unit to capture the image and acquire the state information at least including the image; and a collection step by an information collection device to collect and store the state information acquired by the patrolling processing step.

[0010]

An aspect of the present disclosure is a remote image display method executed in a remote image display system including a patrolling robot and a head-mounted display device mountable on the head of a user, the remote image display method includes a patrol processing step by the patrolling robot including a driving unit being autonomously moveable in a construction field and an imaging unit being able to capture an image to perform an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route, and make the imaging unit to capture the

image; a visual-field-angle information receiving step by the patrolling robot to receive visual-field-angle information transmitted from the head-mounted display device; an extraction step by the patrolling robot to extract an image corresponding to the visual-field-angle in the spherical image that is captured in the construction field by the imaging unit; an image transmission step by the patrolling robot to transmit the extracted extraction image to the head-mounted display device; an orientation detection step by the head-mounted display device to detect an orientation of the head; a visual-field-angle calculation step by the head-mounted display device to calculate visual-field-angle information indicating a direction of visual field corresponding to the detected orientation; a transmission step by the head-mounted display device to transmit the calculated visual-field-angle information to the patrolling robot; an image receiving step by the head-mounted display device to receive the extraction image; and a display step by the head-mounted display device to display the received extraction image.

An aspect of the present disclosure is a field assistance device connected to a distribution board supplying electric power to a construction field, including a display; a collection processing unit collects state

information indicating a state of a surrounding environment of the construction field and at least including an amount of used electric power by the distribution board and stores the collected state information in an information memory unit; an information acquisition unit acquires work information relating to work that at least including design drawings and work instructions in the construction field; and a display control unit makes the display to display management information based on the state information collected by the collection processing unit and the work information acquired by the information acquisition unit.

An aspect of the present disclosure is a field assistance system including a field assistance device connected to a distribution board supplying electric power to a construction field, having a display; a collection processing unit collects state information indicating a state of a surrounding environment of the construction field and at least including an amount of used electric power by the distribution board and stores the collected state information in an information memory unit; an information acquisition unit acquires work information relating to work that at least including design drawings and work instructions in the construction field; and a display control unit makes the display to display management information based on the state information

collected by the collection processing unit and the work information acquired by the information acquisition unit, the distribution board, and a detection unit detects the state information.

[Advantageous Effects of Invention]

[0011]

According to each of the above-mentioned aspects of the present disclosure, appropriate information can be efficiently integrated, collected and managed at the construction field.

[Brief Description of Drawings]

[0012]

Fig. 1 is a view showing a configuration example of a field assistance system according to a first embodiment.

Fig. 2 is a view showing an arrangement example of a smart station according to the first embodiment.

Fig. 3 is a functional block diagram showing an example of the field assistance system according to the first embodiment.

Fig. 4 is a view showing an example of map information and patrol route according to the first embodiment.

Fig. 5 is a view showing an example of a 360-degree image according to the first embodiment.

Fig. 6A is a view showing an example of an extraction image according to the first embodiment.

Fig. 6B is a view showing an example of the extraction image according to the first embodiment.

Fig. 7 is a view showing an example of a progress management table according to the first embodiment.

Fig. 8 is a view showing an example of a progress state map according to the first embodiment.

Fig. 9 is a flowchart showing an example of information collection processing of a patrolling robot according to the first embodiment.

Fig. 10 is a view showing an example of progress management processing of the field assistance system according to the first embodiment.

Fig. 11 is a functional block view showing an example of a field assistance system according to a second embodiment.

Fig. 12 is a functional block view showing an example of a field assistance system 1b according to a third embodiment.

Fig. 13 is a concept view for describing a situation of transmitting an extraction image from a patrolling robot 10a to a head-mounted display device 90.

Fig. 14 is a view showing an example of an image that is displayed on the head-mounted display device 90.

[Description of Embodiments]

[0013]

Hereinafter, a patrolling robot, a field assistance device, and a field assistance system according to an embodiment of the present disclosure will be described with reference to the drawings.

[0014]

[First Embodiment]

A field assistance system 1 according to a first embodiment is a system installed at a construction field. The field assistance system 1 is an information collection system that collects various information on the construction field, and also manages various information related to the work on the construction field to display the information on a display 23. The field assistance system 1 is an assistance system that assists the construction work by providing various information at the construction field.

[0015]

Fig. 1 is a view showing a configuration example of the field assistance system 1 according to the present embodiment.

As shown in Fig. 1, the field assistance system 1 includes a patrolling robot 10, a smart station 20, a smart distribution board 30 (30-1, 30-2, 30-3, 30-4), a field server 40, and an external server 50.

[0016]

In the present embodiment, each of the smart distribution board 30-1, the smart distribution board 30-2, the smart distribution board 30-3, and the smart distribution board 30-4 has the same configuration. In a case of showing either smart distribution board provided in the field assistance system 1, or in a case in which it is not particularly distinguished, it will be described as a smart distribution board 30.

[0017]

The patrolling robot 10 automatically patrols the construction field and collects state information indicating the state of the surrounding environment of the construction field. The state information is, for example, captured image data obtained by capturing an image of the construction field, detection information by various sensors, and the like. The patrolling robot 10 periodically (for example, every two hours) patrols to collect the state information such as the captured image data while after the patrol, connects to the smart station 20 to store the collected state information. The patrolling robot 10 performs inspection patrols and temporary patrols according to the instructions from the user and confirms and inspects various states.

[0018]

The patrolling robot 10 may be configured such that

when connected to the smart station 20, a battery (not shown) used as a power source for automatic patrol is charged by the smart station 20.

[0019]

The smart station 20 (an example of the field assistance device) is an information collection device that collects and stores the state information acquired by the patrolling robot 10. The smart station 20 is connected to the smart distribution board 30 (30-1 to 30-4) that supplies power to the construction field, and the smart station 20 collects the state information including at least the amount of power used by the smart distribution board 30, the captured image data collected by the patrolling robot 10 and the like.

[0020]

The smart station 20 acquires work information related to the work including at least design drawings and work instructions at the construction field from a field server 40 or an external server 50. The smart station 20 causes the display 23 to display the management information based on the state information and the work information acquired from the field server 40 or the external server 50.

[0021]

The smart distribution board 30 (an example of the distribution board) is installed at the construction field,

and supplies electric power to the construction field in order to use power tools, lighting and the like at the construction field, for example. For example, a predetermined number (for example, four) of the smart distribution boards 30 are installed on each floor of a building under construction. The smart distribution board 30 has a function of detecting an amount of power used and a function of acquiring various state information by using wireless communication such as a wireless LAN.

[0022]

The field server 40 is an information server device installed at the construction field. The field server 40 provides various work information such as the design drawings and the work instructions to the smart station 20 via, for example, a local area network (LAN) constructed in the construction field. The field server 40 is installed in, for example, a field office OF1 at the construction field.

[0023]

The external server 50 is a server device such as a cloud server or the like installed outside the construction field. The external server 50 is connected to a public network NW1 (WAN: Wide Area Network), and provides various work information such as the design drawings and the work instructions to the smart station 20 via the field server

40.

[0024]

Fig. 2 is a view showing an installation example of the smart station 20 according to the present embodiment.

As shown in Fig. 2, a plurality of smart stations 20 are connected to the field server 40. The plurality of smart stations 20 are arranged for each system (for example, for each system K1 and for each system K2) on each floor of a building BLD under construction, for example. The plurality of smart stations 20 are supplied with electric power from the cubicle 80 for each system (for example, for each system K1 and for each system K2).

[0025]

The cubicle 80 is a cubicle-type high-voltage power receiving/transforming facility, which is a power receiving device that steps down high-voltage electricity sent from a power plant through a substation to 100V or 200V. The cubicle 80 supplies the electric power to the smart station 20 and the smart distribution board 30.

[0026]

Next, with reference to Fig. 3, the details of each configuration of the field assistance system 1 according to the present embodiment will be described.

Fig. 3 is a functional block diagram showing an example of the field assistance system 1 according to the

present embodiment.

[0027]

As shown in Fig. 3, the field assistance system 1 includes the patrolling robot 10, the smart station 20, the smart distribution board 30, the field server 40, then external server 50, a sensor unit 60, and a portable terminal 70.

The patrolling robot 10 includes a camera 11, a wireless communication unit 12, a driving unit 13, a memory unit 14, and a control unit 15.

[0028]

The camera 11 (an example of an imaging unit) is, for example, a camera capable of capturing a 360-degree image, and is arranged at a position capable of capturing the 360-degree image (captured image data) around the patrolling robot 10. For example, the camera 11 captures the 360-degree image when the patrolling robot 10 patrols the construction field.

[0029]

The wireless communication unit 12 communicates with the sensor unit 60 and the like by the wireless communication such as wireless LAN, Bluetooth (registered trademark), and specified low power wireless. For example, the wireless communication unit 12 acquires various state information detected by the sensor unit 60 when the

patrolling robot 10 patrols the construction field.

[0030]

The driving unit 13 is a driving device capable of autonomously moving the patrolling robot 10 at the construction field, and includes, for example, a motor for driving, a battery, and various sensors for a position detection or detecting an obstacle.

[0031]

The memory unit 14 stores various information used by the patrolling robot 10. The memory unit 14 includes, for example, a map information memory unit 141, a patrol route memory unit 142, and a collecting-information memory unit 143.

[0032]

The map information memory unit 141 stores the map information of the construction field to which the patrolling robot 10 patrols. The map information memory unit 141 stores, for example, the map information MAP as shown in Fig. 4.

Fig. 4 is a view showing an example of the map information and a patrol route according to the present embodiment.

In the example shown in Fig. 4, the map information MAP shows, for example, a map of the floors of the building under construction. That is, the map information memory

unit 141 may be configured to store the map information for each floor of the building under construction.

[0033]

Returning to the explanation of Fig. 3, the patrol route memory unit 142 stores the patrol route through which the patrolling robot 10 patrols. The patrol route memory unit 142 stores, for example, a predetermined patrol route RT including a plurality of nodes (node NDs), as shown in Fig. 4. The node ND is a black circle on the patrol route RT shown in Fig. 4, and is a location for acquiring the state information indicating the state of the surrounding environment of the construction field.

[0034]

Returning to the explanation of Fig. 3 again, the collecting-information memory unit 143 stores the state information collected by the patrolling robot 10 for each node. The collecting-information memory unit 143 stores, for example, the 360-degree image data, various information collected from the sensor unit 60 and the portable terminal 70, and the like as the state information. The collecting-information memory unit 143 may be configured to store the state information for each node and the acquired date and time information in association with each other.

[0035]

The control unit 15 is, for example, a processor

including a CPU (Central Processing Unit) and the like, and integrally controls the patrolling robot 10. The control unit 15 includes, for example, a patrol processing unit 151 and a collection processing unit 152.

[0036]

The patrol processing unit 151 makes the patrolling robot 10 to autonomously move by the driving unit 13 based on the map information of the construction field and the patrol route, and when the patrolling robot 10 reaches the node, makes the camera 11 to capture the 360-degree image to acquire the state information at least including the 360-degree image. The patrol processing unit 151 periodically (for example, for every two hours) utilizes the driving unit 13 to move the patrolling robot 10 along the patrol route based on, for example, the map information stored in the map information memory unit 141 and the patrol route stored in the patrol route memory unit 142.

In a case of performing the inspection patrol or the temporary patrol, the patrol processing unit 151 executes the patrol processing to move the patrolling robot 10 to move along the instructed patrol route by using the driving unit 13 in response to the instructions of the user that are received by the smart station 20.

[0037]

In a case of reaching the node on the patrol route,

the patrol processing unit 151 acquires the captured 360-degree image data at each node from the camera 11 as the state information, for example, as the image G1 shown in Fig. 5. The patrol processing unit 151 acquires the detection information detected by the sensor unit 60 at the node, the information from the mobile terminal possessed by the worker around the node, and the like as the state information from the wireless communication unit 12.

The patrol processing unit 151 stores the acquired state information in the collecting-information memory unit 143 for each node.

[0038]

The collection processing unit 152 stores the state information acquired by the patrol processing unit 151 in the smart station 20. The collection processing unit 152 transmits the state information stored in the collecting-information memory unit 143 to the smart station 20 and makes the collecting-information memory unit 242 of the smart station 20 to store the state information in a case in which the patrolling robot 10 whose periodic patrol is completed is connected to the smart station 20.

[0039]

The field server 40 includes an extraction processing unit 41, a progress management unit 42, and a control instruction unit 43.

The extraction processing unit 41 (an example of a division processing unit) divides the 360-degree image acquired by the patrol processing unit 151 into partial images in a predetermined range. The extraction processing unit 41 generates extracted image data (partial image) from the 360-degree image data, for example, as shown in Fig. 6B. Here, with reference to Fig. 6A and Fig. 6B, the details of the generation processing of the extracted image data by the extraction processing unit 41 will be described.

[0040]

Fig. 6A and Fig. 6B are views showing an example of the extracted image according to the present embodiment.

The extraction processing unit 41 acquires the 360-degree image from the collecting-information memory unit 242 of the smart station 20, and divides the 360-degree image into five parts such as front, back, left, right, and an upper surface (ceiling), as shown in Fig. 6A to generate the extracted image data. The extraction processing unit 41 generates, for example, the extracted images SG1 to the extracted images SG4 and the extracted images SG0 of the ceiling.

[0041]

Fig. 6B shows an example in which the 360-degree image G1 shown in Fig. 5 is divided into five partial images of

the extracted image SG0 to the extracted image SG4. The extraction processing unit 41 additionally stores the generated (divided) extracted images SG0 to the extracted images SG4 as the state information for each node in the collecting-information memory unit 242 of the smart station 20, which will be described later.

[0042]

Returning to the explanation of Fig. 3 again, the progress management unit 42 generates progress information indicating the progress of work at the construction field based on the captured image data acquired by the patrolling robot 10. The progress management unit 42 generates the progress information indicating the progress state of the work for each node, for example, based on the extracted image data (partial image) divided by the extraction processing unit 41. The progress management unit 42 diagnoses the progress of each of the divided extracted image data and generates the progress information. The progress management unit 42, for example, compares the extracted image data for each node stored in the collecting-information memory unit 242 by the date and time indicated by the date and time information, and generates the progress information for each node. The progress management unit 42 stores the generated progress information in the management information memory unit 243

of the smart station 20.

[0043]

The progress management unit 42 generates the progress information for each type of work and generates a progress management table that summarizes the progress information for each type of work. The progress management unit 42 generates, for example, the progress management table as shown in Fig. 7.

Fig. 7 is a view showing an example of the progress management table according to the present embodiment.

As shown in Fig. 7, the progress management unit 42 represents the progress information corresponding to each work process from 0% to 100%, and for example, generates the progress management table summarized in a table for each floor number and room name of the construction field. The progress management unit 42 stores the generated progress management table in the management information memory unit 243 of the smart station 20.

[0044]

Based on the progress information, the progress management unit 42 visualizes the progress state of the work and generates a progress state map superimposed on the map information. The progress management unit 42 generates, for example, the progress map as shown in Fig. 8.

Fig. 8 is a view showing an example of the progress

map according to the present embodiment.

[0045]

As shown in Fig. 8, the progress management unit 42 displays the map information MAP shown in the above-described Fig. 4 based on the progress information as "out of range", "-60%" (less than 60%), "-80%" (equal to or more than 60% and less than 80%), and "-100%" (equal to or more than 80% and less than 100%) in response to the progress information to be visually distinguishable and generates the progress state map. The progress management unit 42 stores the generated progress map in the management information memory unit 243 of the smart station 20.

[0046]

The control instruction unit 43 receives various instructions from the user of the field office OF1 and transmits various instructions to the smart station 20 to execute various controls. The control instruction unit 43 transmits an instruction to control the smart distribution board 30 from the field office OF1, such as remotely stopping the power supply, to the smart station 20 and causes the smart station 20 to execute the instruction.

[0047]

The sensor unit 60 (an example of the detection unit) detects various state information. The sensor unit 60 detects, for example, temperature, humidity, wind speed

information, noise information, vibration information, and the like as the state information. The sensor unit 60 has, for example, the wireless communication function, and when the patrolling robot 10 approaches the vicinity of the sensor unit 60, the detected state information is transmitted to the patrolling robot 10.

[0048]

The portable terminal 70 is, for example, a mobile phone, a smartphone, or the like possessed by the worker. In a case in which the patrolling robot 10 approaches the vicinity of the sensor unit 60, the portable terminal 70 transmits information regarding the worker (for example, identification information for identifying the worker, vital information of the worker, work content, or the like) as the state information to the patrolling robot 10 by the wireless communication.

[0049]

The sensor unit 60 and the portable terminal 70 can be connected to, for example, the on-field network NW2, and may be configured to transmit the state information to the smart station 20 via the on-field network NW2 and store the state information in collecting-information memory unit 242 of the smart station 20.

[0050]

The smart station 20 includes a NW (network)

communication unit 21, an input unit 22, a display 23, a device memory unit 24, and a device control unit 25.

The NW communication unit 21 is a communication unit that communicates by, for example, a wired LAN or a wireless LAN, and the NW communication unit 21 is connectable to the field server 40. The NW communication unit 21 is connectable to the public network NW1 via the field server 40. The NW communication unit 21 receives the work information from, for example, the field server 40 or the external server 50.

[0051]

The input unit 22 is, for example, an input device such as a touch panel, and receives various inputs from the user.

The display 23 is, for example, a display device such as a liquid crystal display, and displays the management information based on the state information collected by the smart station 20, the work information acquired from the field server 40 or the external server 50, and the like.

[0052]

The device memory unit 24 stores various information used by the smart station 20. The device memory unit 24 includes, for example, a work information memory unit 241, a collecting-information memory unit 242, and a management information memory unit 243.

[0053]

The work information memory unit 241 stores the work information related to the work such as the design drawings, the work instructions and the like at the construction field, for example. The work information memory unit 241 stores the work information acquired by an information acquisition unit 252, which will be described later.

[0054]

The collecting-information memory unit 242 (an example of the information memory unit) stores the state information collected by the patrolling robot 10, the smart distribution board 30, the sensor unit 60, the portable terminal 70, and the like. The collecting-information memory unit 242 stores, for example, the state information collected by the patrolling robot 10 in association with the date and time information for each node.

[0055]

The management information memory unit 243 stores various management information generated based on the collected state information. The management information includes, for example, progress information such as the progress management table and the progress map, power monitoring information, worker information, and the like.

[0056]

The device control unit 25 is, for example, a processor including a CPU and the like, and integrally controls the smart station 20. The device control unit 25 included, for example, a collection processing unit 251, an information acquisition unit 252, an aggregation processing unit 253, a power monitoring unit 254, a worker management unit 255, a material/equipment management unit 256, and a display control unit 257.

[0057]

The collection processing unit 251 collects the above-mentioned state information, and stores the collected state information in the collecting-information memory unit 242. The collection processing unit 251 stores, for example, the state information acquired via the patrolling robot 10 or the smart distribution board 30 in the collecting-information memory unit 242. The collection processing unit 251 associates the state information (for example, the captured 360-degree image data, the extracted image data, and the like) collected by the patrolling robot 10 with the date and time information for each node, and stores the state information in the collecting-information memory unit 242.

The collection processing unit 251 collects, for example, the amount of power used by the smart distribution board 30 as the state information, and stores the collected

state information in the collecting-information memory unit 242.

[0058]

The information acquisition unit 252 acquires the work information related to the work including at least the design drawings and the work instructions at the construction field. The work information is, for example, the design drawings, the work instruction sheet, information on safety standards and the like to be viewed at the construction field, and the information acquisition unit 252 acquires the work information via the NW communication unit 21, for example, from the field server 40 or the external server 50. The information acquisition unit 252 stores the acquired work information in the work information memory unit 241.

[0059]

The aggregation processing unit 253 aggregates the amount of used power that is collected by the collection processing unit 251. The aggregation processing unit 253, for example, aggregates the amount of used power at the construction field that is collected from the smart distribution board 30, and stores the aggregation result in the management information memory unit 243.

[0060]

The power monitoring unit 254 monitors the consumption

power based on the aggregation result that is aggregated by the aggregation processing unit 253. The power monitoring unit 254 monitors the power consumption by comparing the power consumption for each day and time period with the planned power consumption, for example. The power monitoring unit 254 may be configured to cause the display 23 to display a warning message via the display control unit 257, which will be described later, in a case in which the power consumption has exceeded or may exceed the planned power consumption. The power monitoring unit 254 stores, for example, a comparison result (for example, a graph, a table) between the aggregated result of the used power amount and the planned power amount in the management information memory unit 243.

[0061]

The worker management unit 255 generates the worker information indicating the work status of the workers (for example, whether the scheduled work is being performed or the like) based on the extracted image data (partial image) divided by the extraction processing unit 41. The worker management unit 255 uses, for example, the conventional image recognition technique to identify the worker included in the extracted image data and determine the work status of the worker.

[0062]

The worker management unit 255 may be configured to generate the worker information indicating the work status of the workers by using the information (for example, the identification information of the worker) collected from the portable terminals 70 possessed by the workers. The worker information is, for example, information such as the number of workers and work contents, and the management information in which the worker information is summarized in a table or a graph. The worker management unit 255 stores the generated worker information in the management information memory unit 243.

[0063]

The material/equipment management unit 256 manages the quantity of materials and equipment used at the construction field. The material/equipment management unit 256 changes the material/equipment management information stored in the management information memory unit 243 in response to, for example, the delivery of the material/equipment to the construction field and the use of the material/equipment.

[0064]

The display control unit 257 causes the display 23 to display the management information based on the state information collected by the collection processing unit 251 and the work information acquired by the information

acquisition unit 252. The display control unit 257 switches the information to be displayed according to the operation information received due to the operation of the user, for example, and causes the display 23 to display the information.

[0065]

The display control unit 257 causes the display 23 to display, for example, the aggregation result of the amount of used power aggregated by the aggregation processing unit 253 and the monitoring result monitored by the power monitoring unit 254 as the management information. The display control unit 257 causes the display 23 to display the progress information (for example, the progress management table, the progress state map, and the like) generated by the progress management unit 42 as the management information.

[0066]

The display control unit 257 causes the display 23 to display the worker information generated by the worker management unit 255 as the management information, for example.

The display control unit 257 causes the display 23 to display, for example, the material/equipment management information changed and managed by the material/equipment management unit 256 as the management information.

In this way, the display control unit 257 selects the management information stored in the management information memory unit 243 according to the operation of the user and displays the management information on the display 23.

[0067]

The state information includes temperature, humidity, wind speed information, noise information, or vibration information. The display control unit 257 causes the display 23 to display management information based on, for example, temperature, humidity, wind speed information, noise information, or vibration information.

The work information includes, for example, design drawings and work instructions at the construction field, information on safety standards at the construction field, and the like. The display control unit 257 selects, for example, the design drawings, the work instructions, and the information on safety standards as work information according to the operation of the user, and causes the display 23 to display the information. That is, the display control unit 257 selects the work information stored in the work information memory unit 241 according to the operation of the user and displays the work information on the display 23.

[0068]

In addition to the above-described information, the

display control unit 257 may be configured to make the display 23 to display, for example, confirmation information regarding the lifting/operating status of the TC (tower crane)/ELV (elevator), digital signage information such as no trespassing and the like, status of the steel frame, the entrance/exit of the vehicle, the inspection status, the entry/exit management information of the worker and the like.

[0069]

Next, the operation of the field assistance system 1 according to the present embodiment will be described with reference to Fig. 9.

Fig. 9 is a flowchart showing an example of information collection processing of the patrolling robot 10 according to the present embodiment. It is assumed that the patrolling robot 10 is normally arranged at the position of the smart station 20 and is connected to the smart station 20.

[0070]

As shown in Fig. 9, the patrolling robot 10 first determines whether or not the patrol time has come (step S101). The patrol processing unit 151 of the patrolling robot 10 determines, for example, whether or not the patrol time has been reached every two hours. In a case in which the patrol processing unit 151 determines that the patrol

time is reached (Step S101: YES), the patrol processing unit 151 proceeds the processing to Step S102, and the patrolling robot 10 starts autonomous movement from the position of the smart station 20. When the patrol processing unit 151 determines that the patrol time is not reached (Step S101: NO), the patrol processing unit 151 returns the processing to Step S101.

In the example shown in Fig. 9, the patrolling robot 10 patrols for every two hours, and in a case of performing the inspection patrol or the temporary patrol according to the instructions from the user, the patrol processing unit 151 similarly proceeds the processing to Step S102.

[0071]

In Step S102, the patrol processing unit 151 moves the patrolling robot 10 to the position of the node based on the map information and the patrol route. The patrol processing unit 151 uses the driving unit 13 based on, for example, the map information stored in the map information memory unit 141 and the patrol route stored in the patrol route memory unit 142 to move the patrolling robot 10 to the position of the next node along the patrol route.

[0072]

Next, the patrol processing unit 151 captures the 360-degree image and acquires various state information (Step S103). The patrol processing unit 151 makes the camera 11

to take the 360-degree image at the position of the node, acquires the 360-degree image data while obtaining various state information (for example, temperature, humidity, wind speed information, noise information, vibration information and the like). The patrol processing unit 151 stores various state information including the acquired 360-degree image data in the collecting-information memory unit 143.

[0073]

Next, the patrol processing unit 151 determines whether or not the current node is the last node on the patrol route (Step S104). In a case in which the current node is the last node (Step S104: YES), the patrol processing unit 151 proceeds the processing to Step S105. If the current node is not the last node (Step S104: NO), the patrol processing unit 151 returns the processing to Step S102 and moves the patrolling robot 10 to the position of the next node.

[0074]

In step S105, the patrol processing unit 151 returns to the position of the smart station and connects to the smart station 20. The patrol processing unit 151 uses the driving unit 13 to move the patrolling robot 10 to the position of the smart station 20 along the patrol route, and connects the smart station 20 and the patrolling robot 10.

[0075]

Next, the collection processing unit 152 of the patrolling robot 10 transmits and stores the state information to the smart station 20 (Step S106). The collection processing unit 152 transmits various state information stored in the collecting-information memory unit 143 to the smart station 20 and stores the state information in the collecting-information memory unit 242 of the smart station 20. After the processing of Step S106, the collection processing unit 152 returns the processing to Step S101 and makes the patrolling robot 10 wait at the position of the smart station 20 until the next patrol time.

[0076]

Next, with reference to Fig. 10, the progress management processing of the field assistance system 1 according to the present embodiment will be described.

Fig. 10 is a flowchart showing an example of the progress management processing of the field assistance system 1 according to the present embodiment.

[0077]

As shown in Fig. 10, the smart station 20 of the field assistance system 1 firstly determines whether or not a storage request for the state information has been received (Step S201). The collection processing unit 251 of the

smart station 20 is connected to the patrolling robot 10 and determines whether or not the storage request for the state information from the collection processing unit 152 of the patrolling robot 10 has been received. In a case in which the collection processing unit 251 receives the storage request (Step S201: YES), the collection processing unit 251 proceeds the processing to Step S202. In a case in which the storage request is not received (Step S201: NO), the collection processing unit 251 returns the processing to Step S201.

[0078]

In Step S202, the collection processing unit 251 stores the state information in the collecting-information memory unit 242. The collection processing unit 251 receives the state information (for example, 360-degree image data) collected by the patrolling robot 10 due to the patrol, and stores the state information in the collecting-information memory unit 242.

[0079]

Next, the extraction processing unit 41 of the field server 40 generates the extracted image from the 360-degree image (Step S203). The extraction processing unit 41 divides the 360-degree image data according to the instruction from the device control unit 25, and generates five extracted images (for example, image SG0 to image SG4)

as shown in Fig. 6. The extraction processing unit 41 stores the generated extracted image data in the collecting-information memory unit 242 of the smart station 20 as a part of the state information.

[0080]

Next, the progress management unit 42 of the field server 40 generates the progress information from the state information (Step S204). According to an instruction from the device control unit 25, the progress management unit 42 compares, for example, the extracted image data for each node stored in the collecting-information memory unit 242 with the date and time indicated by the date and time information to generate the progress information for each node. The progress management unit 42 stores the generated progress information in the management information memory unit 243.

[0081]

Next, the progress management unit 42 generates the progress management table and the progress state map from the progress information (Step S205). The progress management unit 42 generates, for example, the progress management table as shown in Fig. 7 and the progress map as shown in Fig. 8 based on the generated progress information.

[0082]

Next, the progress management unit 42 stores the progress management table and the progress state map in the management information memory unit 243 (Step S206). After the processing of Step S206, the progress management unit 42 returns the processing to Step S201.

[0083]

Next, the processing for displaying various information of the smart station 20 according to the present embodiment will be described.

The display control unit 257 of the smart station 20 selects various information such as the work information stored in the work information memory unit 241, the management information stored in the management information memory unit 243 and the like according to the operation of the user by the input unit 22, and then make the information to be displayed on the display 23.

[0084]

As described above, the patrolling robot 10 according to the present embodiment includes the driving unit 13 capable of autonomously moving around the construction field, the camera 11 (imaging unit) capable of capturing the image (for example, the 360-degree image), and the patrol processing unit 151. The patrol processing unit 151 makes the patrolling robot 10 to autonomously move by the driving unit 13 based on the map information (for example,

the map information shown in Fig. 4) of the construction field and the predetermined patrol route (for example, the patrol route RT shown in Fig. 4) including the node that is the location for acquiring the state information indicating the state of the surrounding environment of the construction field. In a case in which the patrolling robot 10 reaches the node, the patrol processing unit 151 makes the camera 11 to take an image and acquires at least the state information including the image.

[0085]

As a result, it is possible for the patrolling robot 10 according to the present embodiment to, for example, efficiently obtain appropriate information without depending on the movement of construction staff such as workers and the like so as to autonomously patrol the construction field to collect the state information. Therefore, the patrolling robot 10 according to the present embodiment can improve the convenience at the construction field.

[0086]

The patrolling robot 10 according to the present embodiment includes the collection processing unit 152 that stores the state information acquired by the patrol processing unit 151 in the smart station 20 (information collection device).

As a result, the patrolling robot 10 according to the present embodiment can automatically store the collected state information in the smart station 20 (information collection device) such that it is possible to further efficiently collect the appropriate information at the construction field.

[0087]

The patrolling robot 10 according to the present embodiment may include the extraction processing unit 41 (division processing unit) configured to divide the image acquired by the patrol processing unit 151 (for example, the 360-degree image) into partial images in a predetermined range (for example, the above-mentioned extracted image). In this case, the collection processing unit 152 includes the partial images (for example, the above-mentioned extracted image) in the state information and stores it in the smart station 20 for each node.

As a result, the patrolling robot 10 according to the present embodiment can efficiently determine, for example, the progress of work by dividing the image (for example, the 360-degree image).

[0088]

The field assistance system 1 (information collection system) according to the present embodiment includes the patrolling robot 10 described above and the smart station

20 that collects and stores the state information acquired by the patrolling robot 10.

As a result, the field assistance system 1 according to the present embodiment has the same effect as the patrolling robot 10 described above, and can collect appropriate information more efficiently at the construction field.

[0089]

The field assistance system 1 according to the present embodiment includes the extraction processing unit 41 and the progress management unit 42. The extraction processing unit 41 divides the 360-degree image acquired by the patrol processing unit 151 into partial images in the predetermined range (for example, the above-mentioned extracted image). The progress management unit 42 generates the progress information indicating the progress state of the work for each node based on the partial images (for example, the above-mentioned extracted image) divided by the extraction processing unit 41.

[0090]

As a result, the field assistance system 1 according to the present embodiment can grasp the progress information at the construction field so as to appropriately manage the construction field while improving the convenience.

[0091]

In the present embodiment, the progress management unit 42 generates the progress information for each type of work, and generates the progress management table (for example, see Fig. 7) in which the progress information for each type of work is shown in the table.

As a result, the field assistance system 1 according to the present embodiment can grasp the progress information for each type of work so as to appropriately manage the construction field while improving the convenience.

[0092]

In the present embodiment, the progress management unit 42 visualizes and superimposes the progress state of the work on the map information based on the progress information to generate the progress state map.

As a result, the field assistance system 1 according to the present embodiment can visually grasp the progress of the work by superimposing it on the map information so as to appropriately manage the construction field while improving the convenience.

[0093]

The field assistance system 1 according to the present embodiment includes the worker management unit 255 that generates the worker information indicating the work state

of the workers based on the partial images (for example, the above-mentioned extracted images) divided by the extraction processing unit 41.

As a result, the field assistance system 1 according to the present embodiment can easily grasp the work state of the workers so as to appropriately manage the construction field while improving the convenience.

[0094]

In the field assistance system 1 according to the present embodiment, the information collection device is, for example, the smart station 20. The smart station 20 is connected to the smart distribution board 30 (distribution board) that supplies the electric power to the construction field, and includes the display 23, the collection processing unit 251, the information acquisition unit 252, and the display control unit 257. The collection processing unit 251 collects the state information including at least the amount of power used by the smart distribution board 30, and stores the collected state information in the collecting-information memory unit 242 (information memory unit). The information acquisition unit 252 acquires the work information related to the work including at least the design drawings and the work instructions at the construction field. The display control unit 257 causes the display 23 to display the state information collected by

the collection processing unit 251 and the work information acquired by the information acquisition unit 252.

[0095]

As a result, in the field assistance system 1 according to the present embodiment, various information used at the construction field can be integrated, collected and centrally managed by using the smart station 20, which further improves efficiency and convenience.

[0096]

The information collection method according to the present embodiment includes a patrol processing step and a collection step. In the patrol processing step, the patrolling robot 10 described above is autonomously moved by the driving unit 13 based on the map information of the construction field and the predetermined patrol route including the node as the location of obtaining the state information indicating the state of the surrounding environment of the construction field, while in a case of reaching the node, the patrolling robot 10 makes the camera 11 to capture the image (for example, the 360-degree image) to acquire at least state information including the image. Here, the patrolling robot 10 includes the driving unit 13 capable of autonomously moving around the construction field, and the camera 11 capable of capturing the image. Further, in the collection step, the smart station 20

(information collection device) collects and stores the state information acquired due to the patrol processing step.

[0097]

As a result, the information collection method according to the present embodiment has the same effect as the patrolling robot 10 and the field assistance system 1 (information collection system) described above, and it is possible to efficiently collect the appropriate information at the construction field.

[0098]

The smart station 20 (field assistance device) according to the present embodiment is a field assistance device connected to the smart distribution board 30 (distribution board) that supplies the electric power to the construction field, and includes the display 23, the collection processing unit 251, the information acquisition unit 252, and the display control unit 257. The collection processing unit 251 collects the state information indicating the state of the surrounding environment of the construction field, including at least the amount of power used by the smart distribution board 30, and stores the collected state information in the collecting-information memory unit 242 (information memory unit). The information acquisition unit 252 acquires the work information related

to the work including at least the design drawings and work instructions at the construction field. The display control unit 257 causes the display 23 to display the management information based on the state information collected by the collection processing unit 251 and the work information acquired by the information acquisition unit 252.

[0099]

Accordingly, the smart station 20 according to the present embodiment can integrate, collect and centrally manage various information used at the construction field (for example, state information, management information based on the state information, work information, and the like). Therefore, the smart station 20 according to the present embodiment can improve the convenience at the construction field.

[0100]

The smart station 20 according to the present embodiment has advantages in the following points, for example, and can improve convenience at the construction field.

(1) The smart station 20 can manage the electric power at the construction field. That is, the smart station 20 can manage the leakage and the power consumption at the construction field.

(2) The smart station 20 has a function as a terminal

for collecting information at the construction field.
Further, the smart station 20 can function as a
communication station such as a wireless LAN or the like.

(3) The smart station 20 functions as a station of the
patrolling robot 10.

[0101]

The smart station 20 according to the present
embodiment may be used, for example, for viewing work
instructions, checking drawings for workers, communicating
and sharing various information at the construction field
when holding a split morning assembly and a KY (danger
prediction) meeting, and viewing and confirming various
information at the countermeasure meetings when problems
occur at the construction field. The smart station 20
according to the present embodiment can efficiently
perform, for example, monitoring of electric energy,
monitoring and management of the smart distribution board
30 (distribution board), management of people (workers),
checking of afterglow and the like so as to improve the
convenience.

[0102]

The smart station 20 according to the present
embodiment has the aggregation processing unit 253 that
aggregates the amount of used power that is collected by
the collection processing unit 251 and the power monitoring

unit 254 that monitors the power consumption based on the aggregation result aggregated by the aggregation processing unit 253. Then, the display control unit 257 causes the display 23 to display the aggregation result and the monitoring result monitored by the power monitoring unit 254 as the management information.

[0103]

As a result, the smart station 20 according to the present embodiment displays the aggregated result of the used power and the monitoring result of the used power on the display 23 so as to appropriately grasp and manage the power used in the smart distribution board 30 (distribution board) at the construction field and further improve the convenience.

[0104]

The state information includes the captured image data that captures the state of the surrounding environment at the construction field. The display control unit 257 causes the display 23 to display the progress information indicating the progress of work at the construction field, which is generated based on the captured image data, as the management information. The smart station 20 includes the progress management unit 42 that generates the progress information indicating the progress state of the work at the construction field based on the captured image data,

and the display control unit 257 may be configured to make the display 23 to display the progress information generated by the progress management unit 42 as the management information.

[0105]

As a result, the smart station 20 according to the present embodiment displays the progress information on the display 23, so as to appropriately grasp the progress state of the work at the construction field and further improve the convenience.

[0106]

The smart station 20 according to the present embodiment includes the worker management unit 255 that generates the worker information indicating the work status of the workers based on the captured image data. The display control unit 257 causes the display 23 to display the worker information generated by the worker management unit 255 as the management information.

As a result, the smart station 20 according to the present embodiment can appropriately grasp the work status of the workers so as to further improve the convenience at the construction field.

[0107]

In the present embodiment, the state information includes temperature, humidity, wind speed information,

noise information, or vibration information. The display control unit 257 causes the display 23 to display the management information based on temperature, humidity, wind speed information, noise information, or vibration information. The state information may include a heat index information (WBGT) indicating heat instead of the temperature and the humidity.

As a result, the smart station 20 according to the present embodiment can integrate, collect and centrally manage various state information.

[0108]

In the present embodiment, the work information includes information on safety standards at the construction field. The display control unit 257 causes the display 23 to display information relating to the safety standards.

As a result, the smart station 20 according to the present embodiment can display various work information such as the safety standards, and further improve the convenience.

[0109]

The field assistance system 1 according to the present embodiment includes the above-mentioned smart station 20, the smart distribution board 30, and the sensor unit 60 (detection unit) for detecting the state information. The

sensor unit 60, the portable terminal 70, and the camera 11 described above are examples of the detection unit.

As a result, the field assistance system 1 according to the present embodiment has the same effect as the smart station 20 described above, and the field assistance system 1 can integrate, collect, and centrally manage various information used at the construction field.

[0110]

[Second Embodiment]

Next, with reference to Fig. 11, a field assistance system 1a according to a second embodiment will be described.

The field assistance system 1a according to the present embodiment is a modification example that does not include the patrolling robot 10 according to the first embodiment described above.

[0111]

Fig. 11 is a functional block diagram showing an example of the field assistance system 1a according to the second embodiment.

As shown in Fig. 11, the field assistance system 1a includes a smart station 20a, the smart distribution board 30, the field server 40a, the external server 50, the sensor unit 60, and the portable terminal 70.

[0112]

In Fig. 11, the same reference signs are given to the same configurations as those in Fig. 3 described above, and the description thereof will be omitted.

The field assistance system 1a according to the present embodiment has the same basic functions and processing as the field assistance system 1a according to the first embodiment, except that the patrolling robot 10 is not provided.

[0113]

The field server 40a is an information server device installed at the construction field. The field server 40a provides various work information such as design drawings and work instructions to the smart station 20a via, for example, a local area network constructed in the construction field. The field server 40a is installed in, for example, the field office OF1 at the construction field. The field server 40a receives various instructions from the user of the field office OF1 and transmits various instructions to the smart station 20a to execute various controls. The field server 40a transmits an instruction to control the smart distribution board 30 from the field office OF1 such as stopping the power supply remotely to the smart station 20a, and causes the smart station 20 to execute the instruction.

[0114]

The smart station 20a (an example of a field assistance device) is an information collection device that is connected to the smart distribution board 30 (30-1 to 30-4) that supplies electric power to the construction field, and configured to collect and store the state information by the smart distribution board 30 via a wireless network or the like. The smart station 20a collects the amount of power used by the smart distribution board 30.

[0115]

The smart station 20a acquires work information related to the work including at least design drawings and work instructions at the construction field from the field server 40a or the external server 50. The smart station 20a causes the display 23 to display the management information based on the state information and the work information acquired from the field server 40a or the external server 50.

[0116]

The smart station 20a includes the NW communication unit 21, the input unit 22, the display 23, the device memory unit 24, and a device control unit 25a.

[0117]

The device control unit 25a is, for example, a processor including a CPU and the like, and integrally

controls the smart station 20a. The device control unit 25a includes, for example, the collection processing unit 251, the information acquisition unit 252, the aggregation processing unit 253, the power monitoring unit 254, a worker management unit 255a, the material/equipment management unit 256, and the display control unit 257.

[0118]

The worker management unit 255a generates the worker information (for example, the identification information of the worker) indicating the work status of the workers from the information collected from the portable terminals 70 possessed by the workers. The worker management unit 255a stores the generated worker information in the management information memory unit 243.

[0119]

As described above, the smart station 20a according to the present embodiment collects the state information including the amount of power used via the smart distribution board 30 instead of the patrolling robot 10. As a result, the smart station 20a according to the present embodiment has the same effect as the smart station 20 according to the first embodiment described above, and various information used at the construction field (for example, state information, management information based on the state information, work information and the like) can

be integrated, collected and centrally managed. Therefore, the smart station 20a according to the present embodiment can improve the convenience at the construction field.

[0120]

[Third Embodiment]

Next, with reference to Fig. 12, a field assistance system 1b according to a third embodiment will be described.

The field assistance system 1b according to the present embodiment further includes a wireless router 81, a cloud server CS, a wireless router 85, and a head-mounted display device 90 in the first embodiment described above.

[0121]

Fig. 12 is a functional block diagram showing an example of the field assistance system 1b according to the third embodiment.

As shown in Fig. 12, the field assistance system 1b includes a patrolling robot 10a, the smart station 20, the smart distribution board 30, the field server 40, the external server 50, the sensor unit 60, the portable terminal 70, the wireless router 81, the cloud server CS, the wireless router 85, and the head-mounted display device 90.

[0122]

In Fig. 12, the same reference signs are given to the

same configurations as those in Fig. 3 described above, and the description thereof will be omitted.

In the field assistance system 1b according to the present embodiment, the basic functions and processing are basically same with that of the field assistance system 1 according to the first embodiment except for including the wireless router 81, the cloud server CS, the wireless router 85, and the head-mounted display device 90.

[0123]

In the patrolling robot 10a, the camera 11a captures the 360-degree image (omnidirectional image) centered on the patrolling robot 10a, as same as in the first embodiment. The image captured by the camera 11a can be captured as either a still image or a moving image, however, in the third embodiment, a case where a 360-degree moving image is captured will be described. The camera 11a captures a spherical image of a live image at the construction field.

[0124]

The wireless communication unit 12a has the function of the wireless communication unit 12 according to the first embodiment while having a function to wirelessly communicate with the wireless router 81.

The wireless communication unit 12a transmits the image captured by the camera 11a to the wireless router 81.

Here, when an omnidirectional camera is used as the camera 11a, the wireless communication unit 12a acquires the 360-degree (omnidirectional) image data centered on the camera 11 of the patrolling robot 10a from the camera 11a, and sends the image data to the wireless router.

When the resolution of the image captured by the camera 11a is a first resolution, the wireless communication unit 12a transmits the captured image data of the first resolution to the wireless router 81. The first resolution is, for example, a 4K resolution as a resolution of 3840×2160 .

The wireless communication unit 12a has a visual-field-angle receiving function as receiving visual-field-angle information transmitted from the head-mounted display device 90, which represents the direction of the visual field in response to an orientation of the head on which the head-mounted display device 90 is mounted.

The control unit 15 has an extraction unit 153. The extraction unit 153 extracts an image according to the visual-field-angle information from the spherical image captured by the camera 11a. In a case in which the camera 11a is capturing a live image, the extraction unit 153 extracts an image corresponding to the visual-field-angle information from the spherical image which is the live image.

The control unit 15 transmits the extracted image extracted by the extraction unit 153 to the head-mounted display device 90 by the wireless communication unit 12a. The wireless communication unit 12a has an image transmission function of transmitting the extracted image to the head-mounted display device 90.

[0125]

The wireless router 81 is wirelessly connected to the wireless communication unit 12a of the patrolling robot 10a, and is also wirelessly connected to the cloud server CS. The wireless router 81 can communicate at a communication speed capable of receiving the captured image data of the first resolution from the wireless communication unit 12a. The wireless router 81 can communicate with the cloud server CS at a communication speed capable of transmitting the captured image data of the first resolution.

As the wireless router 81, for example, a WiFi (registered trademark) router can be used. The wireless router 81 is portable and may be attached to the patrolling robot 10a. In this case, even when the patrolling robot 10a moves along the patrol route, the patrolling robot 10a captures the surrounding image as the captured image data by the camera 11a while moving, and sends the captured image data to the cloud server CS via the wireless router

81.

Although only one wireless router 81 is shown in Fig. 12, a plurality of wireless routers 81 may be provided at a distance from each other in the construction field. In this case, even when the patrolling robot 10a moves in the construction field, the wireless communication unit 12a can continuously send the captured image data to the cloud server CS by switching and connecting to the wireless router 81 that can be connected at the movement destination.

[0126]

The cloud server CS is wirelessly connected to the wireless router 81 and wirelessly connected to the wireless router 85 to be communicatable therewith. The cloud server CS transmits the captured image data received from the wireless router 81 to the wireless router 85. The cloud server CS may transmit the captured image data of the first resolution received from the wireless router 81 to the wireless router 85 with the first resolution as it is. The cloud server CS may convert the captured image data of the first resolution into the captured image data of the second resolution having a resolution lower than the first resolution and transmit it to the wireless router 85. The second resolution is, for example, a 2K resolution as a resolution of 1920×1080 .

In a case in which the cloud server CS converts the captured image data of the first resolution into the captured image data of the second resolution and then transmits the image data to the wireless router 85, at least the communication delay between the cloud server CS and the wireless router 85 can be reduced.

The cloud server CS can receive the live image of the captured image data from the patrolling robot 10a via the wireless router 81 and performs live streaming to the head-mounted display device 90 via the wireless router 85.

[0127]

The wireless router 85 is wirelessly connected to the cloud server CS and wirelessly connected to the head-mounted display device 90 to be communicatable therewith. The wireless router 85 can communicate at a communication speed capable of receiving captured image data having the second resolution from the cloud server CS. The wireless router 85 can communicate with the head-mounted display device 90 at a communication speed capable of transmitting the captured image data having the second resolution.

Here, the wireless router 85 may communicate at a communication speed capable of receiving the captured image data of the first resolution from the cloud server CS, and communicate at a communication speed capable of transmitting the captured image data having the first

resolution with respect to the head-mounted display device 90.

In a case in which the wireless router 85 receives the captured image data of the second resolution from the cloud server CS and transmits it to the head-mounted display device 90, it is possible to reduce the communication delay as compared with the case of receiving the captured image data of the first resolution from the cloud server CS and transmitting it to the head-mounted display device 90. Therefore, with respect to the head-mounted display device 90, it is possible to reduce the difference between the time when the captured image data is captured by the camera 11a and the time when the captured image data is displayed on the head-mounted display device 90.

As the wireless router 85, for example, a WiFi router can be used. The wireless router 81 may be portable. In Fig. 12, only one wireless router 85 is shown; however, a plurality of wireless routers 85 may be provided therein.

[0128]

The head-mounted display device 90 is wearable on the user's head. As such a head-mounted display device 90, for example, a head-mounted display can be used.

The head-mounted display device 90 includes an orientation detection unit 91, a visual-field-angle calculation unit 92, a communication unit 93, and a display

94.

The orientation detection unit 91 detects the orientation of the head. The visual-field-angle calculation unit 92 obtains visual-field-angle information indicating the direction of the visual field according to the detected orientation of the head. The communication unit 93 has a function of wirelessly connecting to the wireless router 85 to be communicatable with the wireless router 85. The communication unit 93 has a transmission function of transmitting the visual-field-angle information indicating the obtained direction of the visual field to the patrolling robot, and an image receiving function of receiving the extracted image from the patrolling robot 10a.

The display 94 displays the extracted image received from the patrolling robot 10a. The image displayed by the display 94 is an image of a region of the spherical image captured by the camera 11a according to the orientation of the head of the user wearing the head-mounted display device 90. As the display 94, for example, a binocular display panel is used.

[0129]

The head-mounted display device 90 receives the captured image data of the construction field captured by the camera 11a via the wireless router 81, the cloud server

CS, and the wireless router 85, and displays it on the display panel. Here, the captured image data received by the head-mounted display device 90 from the cloud server CS is, for example, the captured image data having the second resolution.

[0130]

A case in which the extracted image is transmitted from the patrolling robot 10a to the head-mounted display device 90 will be described with reference to the conceptual view of Fig. 13.

The orientation detection unit 91 of the head-mounted display device 90 detects the direction D in which the front side of the head is facing by detecting the orientation of the head. By detecting the direction D, it is possible to grasp which direction (upward, downward, rightward, downward and the like) the user is facing.

The visual-field-angle calculation unit 92 obtains the visual-field-angle information indicating the viewing direction of the user based on the direction D detected by the orientation detecting unit 91. Here, among the overall spherical sphere, the direction D corresponds to the direction of the visual field, and the visual-field-angle calculation unit 92 generates the information indicating this direction D as the visual-field-angle information. The communication unit 93 of the head-mounted display device 90

transmits the visual-field-angle information to the patrolling robot 10a (the processing indicated by reference sign 301).

[0131]

In the patrolling robot 10a, when the extraction unit 153 of the control unit 15 receives the visual-field-angle information by the wireless communication unit 12a, the extraction unit 153 extracts an image corresponding to the visual-field-angle information. Here, the spherical image ZT captured by the camera 11a is an image with a circumference of 360 degrees centered on the camera 11a. The extraction unit 153 extracts an extracted image SR as an image in a region of the spherical image ZT corresponding to a region of the visual field in a direction corresponding to the direction represented by the visual-field-angle information from the center of the spherical image ZT. The region being extracted as the extracted image SR among the spherical image ZT may be determined according to the region that can be included in the visual field.

Here, an identification number is assigned to each pixel included in the spherical image ZT, and it is possible to grasp which direction of the spherical image the pixel corresponds to, based on the identification number. The extraction unit 153 can extract the image

included in the range of the visual field based on the direction indicated by the visual-field-angle information and the identification number of each image.

When the extracted image is obtained, the extraction unit 153 transmits the extracted image to the head-mounted display device 90 by the wireless communication unit 12a (the processing indicated by reference sign 302).

When the orientation of the head-mounted display device 90 changes, the head-mounted display device 90 generates and transmits the visual-field-angle information every time the change in orientation is detected or at regular time intervals. Based on this visual-field-angle information, the patrolling robot 10a transmits the extracted image corresponding to the orientation of the head to the head-mounted display device 90. As a result, the extracted image corresponding to the change in the orientation of the head is displayed on the head-mounted display device 90.

[0132]

In this way, the visual-field-angle information is transmitted from the head-mounted display device 90. Since the visual-field-angle information only has to be the information indicating the direction of the visual field, it can be expressed with a small amount of data. Therefore, the load required for the processing of transmitting the

visual-field-angle information can be reduced, and the time required for the transmission can be shortened.

The patrolling robot 10a can transmit the spherical image ZT itself to the head-mounted display device 90; however, it is possible to transmit the extracted image that is extracted according to the visual-field-angle information rather than transmitting the spherical image ZT itself. As a result, the number of pixels to be transmitted can be reduced as compared with the case where the entire image of the spherical image ZT is transmitted. Since the number of pixels to be transmitted can be reduced, a high-definition extracted image can be transmitted to the head-mounted display device 90 even if the communication speed is at the same degree as the communication speed when transmitting the entire image of the spherical image ZT. By viewing the extracted image with the high definition on the head-mounted display device 90, it is possible to provide an image with a sense of presence at the construction field while reducing the delay.

[0133]

By live streaming the captured image data captured by the camera 11a of the patrolling robot 10a, the user of the head-mounted display device 90 can browse the region corresponding to the orientation of the head in the image captured by the spherical camera in real time at a remote

location away from the construction field (for example, even in the field office OF1). By applying the spherical camera as the camera 11, it is possible to capture the image without any visual-field-angle limitation and display the image on the head-mounted display device 90 in the construction field. When the user changes the direction of the head to the direction (left-right, front-back, up-down, and the like) of the place with the camera 11a as the center where he/she wants to check, the head-mounted display device 90 displays the image of the region corresponding to the orientation in the captured image data. As a result, the user can browse the range in the visual field direction centered on the camera 11a by facing the direction according to the place he/she wants to browse. As a result, the operator can obtain a sense of presence.

For example, as shown in Fig. 14, the head-mounted display device 90 displays the work status in the construction field and the like.

[0134]

When the patrolling robot 10a reaches the node ND, the patrolling robot 10a can take an image of the surroundings by the camera 11a at the node ND; however, the patrolling robot 10a may capture an image by the camera 11a while moving. In this case, the patrolling robot 10a stores the

map information of the construction field in the map information memory unit 141, and stores the patrol route in the patrol route memory unit 142. Then, the patrol processing unit 151 of the patrolling robot 10a makes the patrolling robot 10a to move autonomously by the driving unit 13 based on the map information of the construction field and the patrol route while making the camera 11a to capture the 360-degree image. The patrol processing unit 151 may make the camera 11a to take an image at the time of reaching the node ND, or take the image on the route to the object to be captured regardless of whether or not it has reached the node ND. The route to the object to be captured may be stored together with the predetermined patrolling route. The patrol processing unit 151 may control the camera 11a to capture the image following an instruction to start or end imaging that is input from either of the head-mounted display device 90, the smart station 20, and the field server 40 along the patrol route. In this case, it is possible to start imaging from any arbitrary position on the patrol route.

In a case in which the patrolling robot 10a performs imaging while moving, the user can browse the image as if he/she is observing the surroundings while walking in the construction field.

In the third embodiment described above, a generally distributing product can be used as the wireless router 81 and the wireless router 85, and an existing service can also be used as the cloud server CS. Therefore, it is possible to use the general-purpose product to realize the configuration at low cost while live streaming the image data with low delay.

[0136]

In the third embodiment described above, the case in which the captured image data captured by the camera 11a is live streamed has been described; however, the captured image data may be stored in the cloud server CS, or the captured image data may be transmitted to the smart station 20 and stored in the smart station 20. Then, the stored captured image data may be received from the cloud server CS or received from the smart station 20 via the field server 40 so as to be browsed by the head-mounted display device 90. In this case, the state of the construction field at the time of capturing can be confirmed retroactively.

In a case in which the captured image data is stored in the cloud server CS or the smart station 20, the captured image data having the first resolution may be stored. Then, the head-mounted display device 90 may reproduce the captured image data having the first

resolution.

[0137]

The present invention is not limited to the above embodiments, and can be modified without departing from the spirit of the present invention.

For example, in the above embodiments, the example in which the smart station 20 is used as the information collection device for storing the state information collected by the patrolling robot 10 by patrol has been described; however, the present invention is not limited thereto. For example, instead of the smart station 20, another device such as the field server 40 or the external server 50 may be used as the information collection device.

[0138]

In the above embodiments, the example in which the field server 40 includes the extraction processing unit 41 and the progress management unit 42 has been described; however, the present invention is not limited thereto. For example, the smart station 20 or the patrolling robot 10 may be configured to have the functions of the extraction processing unit 41 and the progress management unit 42.

[0139]

In the above embodiments, a part of the functions provided by the smart station 20 may be provided by the patrolling robot 10 or the field server 40. For example,

the patrolling robot 10 or the field server 40 may be configured to have a part or all of the functions of the worker management unit 255.

In the above embodiments, the patrolling robot 10 may be configured to include a lighting device together with the camera 11.

[0140]

In the above embodiments, the example in which the map information is a two-dimensional map as shown in Fig. 4 and the patrol route is also a two-dimensional route has been described; however, the present invention is not limited thereto. For example, when the driving unit 13 of the patrolling robot 10 has a function of being able to move the stairs, the map information and the patrol route may be information corresponding to three dimensions.

[0141]

In the above embodiment, the example in which the smart station 20 performs the work progress management and the worker management based on the captured image data captured by the patrolling robot 10 has been described, however, the present invention is not limited to this example. The smart station 20 may be configured to perform other management such as process management, craftsman management, safety management, and equipment management based on the captured image data.

[0142]

Each configuration of the above-mentioned field assistance system 1 has a computer system inside. Then, a program for realizing the functions of each configuration included in the above-mentioned field assistance system 1 may be recorded on a computer-readable recording medium, and the program recorded on the recording medium may be read into the computer system and executed so as to perform the processing in each configuration provided in the on-field assistance system 1 described above. Here, "loading and executing a program recorded on a recording medium into a computer system" includes installing the program in the computer system. The term "computer system" as used herein includes hardware such as an OS, peripheral devices and the like.

[0143]

The "computer system" may include a plurality of computer devices connected via a network including a communication line such as the Internet, WAN, LAN, and a dedicated line or the like. Further, the "computer-readable recording medium" refers to a portable medium such as a flexible disk, a magneto-optical disk, a ROM, or a CD-ROM, and a storage device such as a hard disk built in a computer system. As described above, the recording medium in which the program is stored may be a non-transient

recording medium such as a CD-ROM.

[0144]

The recording medium also includes an internal or external recording medium accessible from the distribution server for distributing the program. It should be noted that the program may be divided into a plurality of parts, downloaded at different timings, and then combined with each configuration provided in the field assistance system 1, or the distribution server for distributing each of the divided programs may be different. Furthermore, the "computer-readable recording medium" is a configuration holding the program for a certain period of time when the program is transmitted via a network, such as a volatile memory (RAM) inside a computer system that serves as a server or client. Also, the above-described program may be made for realizing a part of the above-mentioned functions. Further, a so-called difference file (difference program) may be used, which can realize the above-mentioned function in combination with a program already recorded in the computer system.

[0145]

A part or all of the above-mentioned functions may be realized as an integrated circuit such as LSI (Large Scale Integration) or the like. Each of the above-mentioned functions may be made into a processor individually, or a

part or all of them may be integrated into a processor. Further, the method of making an integrated circuit is not limited to the LSI, and may be realized by a dedicated circuit or a general-purpose processor. Further, when an integrated circuit technology that replaces LSI appears due to the progress of semiconductor technology, an integrated circuit based on the technology may be used.

[0146]

As described above, the embodiment of the present invention has been described in detail with reference to the drawings, however the specific configuration is not limited to this embodiment, and the design and the like within a range not deviating from the scope of the present invention are also included. The present invention is not limited by the above description, but only by the appended claims.

[Industrial Applicability]

[0147]

According to each of the above-described embodiments, a patrolling robot, an information collection system, a remote image display system, an information collection method, a remote image display method, a field assistance device and a field assistance device system which can efficiently integrate, collect and manage appropriate information at a construction field can be provided.

[Reference Signs List]

[0148]

- 1, 1a field assistance system
- 10, 10a patrolling robot
- 11, 11a camera
- 12, 12a wireless communication unit
- 13 driving unit
- 14 memory unit
- 15 control unit
- 20, 20a smart station
- 21 NW communication unit
- 22 input unit
- 23, 94 display
- 24 device memory unit
- 25, 25a device control unit
- 30, 30-1, 30-2, 30-3, 30-4 smart distribution board
- 40, 40a field server
- 41 extraction processing unit
- 42 progress management unit
- 43 control instruction unit
- 50 external server
- 60 sensor unit
- 70 portable terminal
- 80 cubicle
- 81, 85 wireless router

90 head-mounted display device
91 orientation detection unit
92 view-field-angle calculation unit
93 communication unit
141 map information memory unit
142 patrol route memory unit
143, 242 collecting-information memory unit
151 patrol processing unit
152, 251 collection processing unit
153 extraction unit
241 work information memory unit
243 managing-information memory unit
252 information acquisition unit
253 aggregation processing unit
254 power monitoring unit
255, 255a worker management unit
256 material/equipment management unit
257 display control unit
CS cloud server
NW1 public network
NW2 on-field network
OF1 field office

[CLAIMS]

[Claim 1]

A patrolling robot, comprising:

a driving unit being autonomously moveable in a construction field;

an imaging unit being able to capture an image;
and

a patrol processing unit performs an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding environment of the construction field, and in a case in which the node is reached, makes the imaging unit to capture the image and acquire the state information at least including the image.

[Claim 2]

The patrolling robot according to claim 1, further comprising a collection processing unit for storing the state information acquired by the patrol processing unit in an information collection device.

[Claim 3]

The patrolling robot according to claim 1 or 2,
wherein the imaging unit captures a spherical image in the construction field,

the patrolling robot comprises:

a visual-field-angle information receiving unit receives visual-field-angle information transmitted from a head-mounted display device for displaying the image captured by the imaging unit, the visual-field-angle information indicating a direction of visual field corresponding to an orientation of head to which the head-mounted display device is mounted;

an extraction unit extracts the image corresponding to the visual-field-angle information in the spherical image; and

an image transmission unit transmits an extracted extraction image to the head-mounted display device.

[Claim 4]

An information collection system, comprising:

a patrolling robot, comprising:

a driving unit being autonomously moveable in a construction field;

an imaging unit being able to capture an image; and

a patrol processing unit performs an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding

environment of the construction field, and in a case in which the node is reached, makes the imaging unit to capture the image and acquire the state information at least including the image, and

an information collection device collects and stores the state information acquired by the patrolling robot.

[Claim 5]

The information collection system according to claim 4, further comprising:

a division processing unit divides the image acquired by the patrol processing unit into a partial image in a predetermined range; and

a progress management unit generates progress information indicating progress state of work for each node based on the partial image divided by the division processing unit.

[Claim 6]

The information collection system according to claim 5, wherein the progress management unit generates the progress information for each type of the work and summarize the progress information for each type of the work in a table to generate a progress management table.

[Claim 7]

The information collection system according to claim 5

or 6, wherein the progress management unit visualizes and superimposes the progress state of the work on the map information based on the progress information to generate a progress state map.

[Claim 8]

The information collection system according to any one from claim 5 to 7, further comprising a worker management unit generates worker information indicating work state of workers based on the partial image divided by the division processing unit.

[Claim 9]

The information collection system according to any one from claim 4 to 8,

wherein the information collection device is connected to a distribution board supplies electric power to a construction field, and

the information collection device comprises:

a display;

a collection processing unit collects the state information at least including an amount of used electric power by the distribution board and stores the collected state information in an information memory unit;

an information acquisition unit acquires work information relating to the work that at least including design drawings and work instructions in the construction

field; and

a display control unit makes the display to display the state information collected by the collection processing unit and the work information acquired by the information acquisition unit.

[Claim 10]

A remote image display system, comprising:

a patrolling robot; and

a head-mounted display device,

wherein the patrolling robot comprises:

a driving unit being autonomously moveable in a construction field;

an imaging unit being able to capture an image;

a patrol processing unit performs an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route, and makes the imaging unit to capture the image,

a visual-field-angle information receiving portion receives visual-field-angle information transmitted from the head-mounted display device;

an extraction unit extracts an image corresponding to the visual-field-angle in the spherical image that is captured in the construction field by the imaging unit; and

an image transmission unit transmits the

extracted extraction image to the head-mounted display device,

wherein the head-mounted display device is mountable on the head of a user, and the head-mounted display device comprises:

an orientation detection unit detects an orientation of the head;

a visual-field-angle calculation unit calculates visual-field-angle information indicating a direction of visual field corresponding to the detected orientation;

a transmission unit transmits the calculated visual-field-angle information to the patrolling robot;

an image receiving unit receives the extraction image; and

a display displays the received extraction image.

[Claim 11]

The remote image display system according to claim 10, wherein the imaging unit captures a spherical image as a live image in the construction field, and

the extraction unit extracts an image corresponding to the visual-field-angle information in the spherical image as the live image.

[Claim 12]

An information collection method, comprising:

a patrolling processing step by a patrolling robot including a driving unit being autonomously moveable in a construction field and an imaging unit being able to capture an image to perform an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route including a node as a location to acquire state information indicating a state of a surrounding environment of the construction field, and in a case in which the node is reached, make the imaging unit to capture the image and acquire the state information at least including the image; and

a collection step by an information collection device to collect and store the state information acquired by the patrolling processing step.

[Claim 13]

A remote image display method executed in a remote image display system including a patrolling robot and a head-mounted display device mountable on the head of a user, the remote image display method comprises:

a patrol processing step by the patrolling robot including a driving unit being autonomously moveable in a construction field and an imaging unit being able to capture an image to perform an autonomous movement by the driving unit based on map information of the construction field and a predetermined patrol route, and make the

imaging unit to capture the image;

a visual-field-angle information receiving step by the patrolling robot to receive visual-field-angle information transmitted from the head-mounted display device;

an extraction step by the patrolling robot to extract an image corresponding to the visual-field-angle in the spherical image that is captured in the construction field by the imaging unit;

an image transmission step by the patrolling robot to transmit the extracted extraction image to the head-mounted display device;

an orientation detection step by the head-mounted display device to detect an orientation of the head;

a visual-field-angle calculation step by the head-mounted display device to calculate visual-field-angle information indicating a direction of visual field corresponding to the detected orientation;

a transmission step by the head-mounted display device to transmit the calculated visual-field-angle information to the patrolling robot;

an image receiving step by the head-mounted display device to receive the extraction image; and

a display step by the head-mounted display device to display the received extraction image.

[Claim 14]

A field assistance device connected to a distribution board supplying electric power to a construction field, comprising:

a display;

a collection processing unit collects state information indicating a state of a surrounding environment of the construction field and at least including an amount of used electric power by the distribution board and stores the collected state information in an information memory unit;

an information acquisition unit acquires work information relating to work that at least including design drawings and work instructions in the construction field; and

a display control unit makes the display to display management information based on the state information collected by the collection processing unit and the work information acquired by the information acquisition unit.

[Claim 15]

The field assistance device according to claim 14, further comprising:

an aggregation processing unit aggregates the amount of used power that is collected by the collection processing unit; and

an electric power monitoring unit monitors the used

power based on an aggregation result that is aggregated by the aggregation processing unit,

wherein the display control unit makes the display to display the aggregation result and a monitoring result that is monitored by the electric power monitoring unit as the management information.

[Claim 16]

The field assistance device according to claim 14 or 15,

wherein captured image data by capturing a state of a surrounding environment in the construction field is included in the state information, and

the display control unit makes the display to display progress information that is generated based on the captured image data and indicates progress state of work in the construction field as the management information.

[Claim 17]

The field assistance device according to claim 16, further comprises a worker management unit generates worker information indicating work state of workers based on the captured image data,

wherein the display control unit makes the display to display the worker information generated by the worker management unit as the management information.

[Claim 18]

The field assistance device according to any one from claim 14 to 17,

wherein the state information includes temperature, humidity, wind speed information, noise information, or vibration information, and

the display control unit makes the display to display the management information based on the temperature, the humidity, the wind speed information, the noise information, or the vibration information.

[Claim 19]

The field assistance device according to any one from claim 14 to 18,

wherein the work information includes information relating to a safety standard in the construction field, and

the display control unit makes the display to display information relating to the safety standard.

[Claim 20]

A field assistance system, comprising:

the field assistance device according to any one from claim 14 to 19;

the distribution board; and

a detection unit detects the state information.