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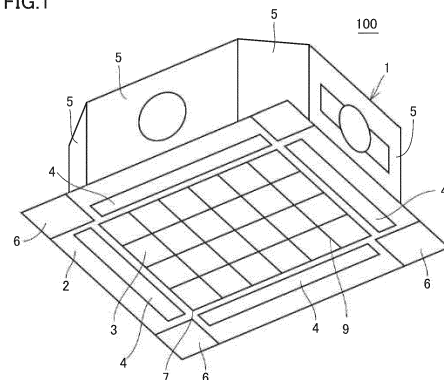
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(54) **AIR-CONDITIONING DEVICE AND AIR-CONDITIONING SYSTEM**

(57) An air-conditioning apparatus (100) includes an indoor unit (1). The indoor unit (1) includes a first panel (2) provided in a front surface where an air outlet (4) is provided in the indoor unit (1), a second panel (7) to which a filter for an air inlet is attached, the second panel being provided in the front surface of the indoor unit (1), and a third panel (5) provided in a side surface of the indoor unit (1). At least one of the first panel (2), the second panel (7), and the third panel (5) is formed from a translucent member.

FIG.1



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air-conditioning apparatus and an air-conditioning system.

BACKGROUND ART

[0002] Design of exterior structures such as various panels in an indoor unit included in a conventional air-conditioning apparatus may be recognized as detriment to design of a structure in an indoor space where the indoor unit is provided. In order to avoid such detriment to the design, the indoor unit may be designed to blend with the design of the indoor space where the indoor unit is provided. In addition, in order to avoid such detriment to the design, the indoor unit may be designed or provided such that the structure is hidden.

[0003] The following is available as an air-conditioning system in consideration of an effect in a design aspect. PTL 1 describes an air-conditioner indoor unit for hanging on a wall provided with a front panel provided on the front of an indoor unit main body and a design cover which comprises a transparent member and which is attached so as to cover the front panel from the front. A pearl paint is coated on a back surface of the design cover and a background color paint is further coated over the pearl paint.

[0004] PTL 2 describes a construction to produce an effect of an air-conditioner as interiors at a location where it is provided, by showing an object different from the air-conditioner on a surface of a cover to cover the air-conditioner.

CITATION LIST

PATENT LITERATURE

[0005]

PTL 1: WO2017/033257

PTL 2: Japanese Patent Laying-Open No. H11-37495

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In recent years, consciousness about sanitation tends to socially increase for various reasons such as measures against infections. In a conventional air-conditioning system, however, a sanitation state including a contamination state in the inside cannot be checked unless a panel of an indoor unit is removed, and a user has been unable to easily check the sanitation state such as the contamination state of the indoor unit.

[0007] An air-conditioning apparatus and an air-conditioning system in the present disclosure solve the problem above, and an object thereof is to allow easy checking of a sanitation state of an indoor unit.

SOLUTION TO PROBLEM

[0008] An air-conditioning apparatus in the present disclosure relates to an air-conditioning apparatus including an indoor unit. The indoor unit includes a first panel provided in a front surface of the indoor unit, an air outlet being provided in the front surface, a second panel provided in the front surface of the indoor unit, a filter for an air inlet being attached to the second panel, and a third panel provided in a side surface of the indoor unit. At least one of the first panel, the second panel, and the third panel is formed from a translucent member.

[0009] An air-conditioning system in the present disclosure includes an indoor unit including a translucent member, the inside of which can be seen through the translucent member, a display apparatus to show two-dimensional code information corresponding to the indoor unit, a terminal to pick up an image of the two-dimensional code information shown on the display apparatus, to pick up an image of the inside from the outside of the indoor unit, and to transmit image data obtained as a result of image pick-up, and a server to make determination as to maintenance of the indoor unit based on the image data transmitted from the terminal. The terminal communicates with the server based on the two-dimensional code information obtained by image pick-up. The server inputs the image data received from the indoor unit to a trained model for inference as to necessity of maintenance of the indoor unit based on the image data of the terminal to make determination as to necessity of maintenance of the indoor unit.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to the air-conditioning apparatus and the air-conditioning system in the present disclosure, a sanitation state of an indoor unit can readily be checked.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

Fig. 1 is a perspective view of an air-conditioning apparatus 100 in a first embodiment.

Fig. 2 is a diagram showing an internal construction of an indoor unit 1 when indoor unit 1 of air-conditioning apparatus 100 in the first embodiment is viewed from below.

Fig. 3 is a diagram showing the internal construction of indoor unit 1 when indoor unit 1 is viewed from a side surface side.

Fig. 4 is a front view of a control panel apparatus 10 included in an air-conditioning system 500 in a second embodiment.

Fig. 5 is a diagram showing a construction of an air-conditioning system 500 in the second embodiment. Fig. 6 is a block diagram showing a configuration of a portable terminal 13 and a server 14 in the second embodiment.

Fig. 7 is a flowchart showing a flow of processing in the system when whether or not maintenance of indoor unit 1 is necessary is checked in air-conditioning system 500.

Fig. 8 is a block diagram showing a configuration used for making determination as to necessity of maintenance of indoor unit 1 in server 14.

Fig. 9 is a diagram showing a configuration of a training device 101.

Fig. 10 is a diagram showing a configuration of a neural network.

Fig. 11 is a flowchart showing a procedure of training by training device 101.

Fig. 12 is a diagram showing a configuration of an inference device 201.

Fig. 13 is a flowchart showing a procedure of inference by inference device 201 and a procedure of set-up of a maintenance plan by a maintenance plan set-up unit 600.

DESCRIPTION OF EMBODIMENTS

[0012] An embodiment of the present disclosure will be described in detail below with reference to the drawings. Though a plurality of embodiments will be described below, combination of features described in the embodiments as appropriate is originally intended. The same or corresponding elements in the drawings have the same reference characters allotted and description thereof will not be repeated.

First Embodiment.

[0013] Fig. 1 is a perspective view of an air-conditioning apparatus 100 in a first embodiment. Fig. 2 is a diagram showing an internal construction of an indoor unit 1 when indoor unit 1 of air-conditioning apparatus 100 in the first embodiment is viewed from below. Fig. 3 is a diagram showing the internal construction of indoor unit 1 when indoor unit 1 is viewed from a side surface side.

[0014] Overview of the construction of air-conditioning apparatus 100 will initially be described. In air-conditioning apparatus 100 in the present embodiment, a refrigerant circuit is constituted by connection of indoor unit 1 and an outdoor unit through a pipe through which refrigerant flows. The outdoor unit provided in an outdoor space which is the outside of a space to be air-conditioned includes, for example, a compressor, an outdoor heat exchanger, and the like, and conveys heat to the indoor unit with refrigerant through the pipe through which refrigerant flows. Indoor unit 1 has an indoor heat exchanger and the like, and heats or cools an indoor space by supplying, by heat exchange, heat conveyed

by refrigerant to air in the indoor space which is the space to be air-conditioned. Among apparatuses that constitute air-conditioning apparatus 100, Fig. 1 shows indoor unit 1 characteristic in the first embodiment and does not show other apparatuses.

[0015] Referring to Fig. 1, for example, indoor unit 1 is attached, for example, to a ceiling in the indoor space as the space to be air-conditioned. Indoor unit 1 includes, as main exterior members, a decorative panel 2 defined as a first panel, a filter panel 7 defined as a second panel, and a side panel 5 defined as a third panel. Indoor unit 1 includes a corner panel 6 as another exterior member.

[0016] Referring to Fig. 1, side panel 5 is a box-shaped panel member to surround side surfaces of indoor unit 1. Decorative panel 2 is a panel member in a shape of a flat plate provided around a lower opening in side panel 5. In a central portion of decorative panel 2, an air inlet 3 is provided. Decorative panel 2 is provided with four air outlets 4. Outlet 4 is provided with a vane to adjust a direction of blow of air. In indoor unit 1, a side where decorative panel 2 is provided is a front side and a side where side panel 5 is provided is a side surface side.

[0017] As shown in Fig. 1, filter panel 7 is a panel member to support a filter 9 below. Filter panel 7 is attached to the central portion of decorative panel 2 such that filter 9 covers air inlet 3.

[0018] Indoor unit 1 is fixed to the ceiling in such a manner that an upper end of side panel 5 is attached to the ceiling. Indoor unit 1 may be attached to the ceiling in such a manner that a part of side panel 5 is fitted into a recess provided in the ceiling.

[0019] As shown in Fig. 2, a fan 23 to suction air through inlet 3 is provided in the inside of indoor unit 1. In the inside of indoor unit 1, a drain pan 22 where drainage such as water produced as a result of heat exchange by the indoor heat exchanger is stored is provided around fan 23. In the inside of indoor unit 1, a pipe 21 through which refrigerant as described previously flows is arranged as being partially exposed. Pipe 21 through which refrigerant flows may be hidden.

[0020] As shown in Fig. 3, in indoor unit 1, pipe 21, drain pan 22, and fan 23 are arranged on an inner side of side panel 5.

[0021] Among members to constitute indoor unit 1 described above, decorative panel 2, filter panel 7, and side panel 5 are formed from translucent members. Filter 9 is also formed of a translucent material. For example, a member made of transparent resin or a member made of glass is employed as the translucent member. A member made of acrylic or polycarbonate is employed as the member made of resin. According to such a construction, in indoor unit 1, the inside can be seen through these exterior members. A person in the indoor space where indoor unit 1 is provided can thus readily visually check a sanitation state such as contamination in the inside of indoor unit 1 from the outside of indoor unit 1, for example, from a lower surface side and the side surface side of indoor unit 1.

[0022] For example, from the lower surface side of indoor unit 1, a state of an internal structure such as pipe 21, drain pan 22, and fan 23 arranged as shown in Fig. 2 can readily visually be checked through decorative panel 2 and filter panel 7 formed from the translucent members. From the side surface side of indoor unit 1, a state of the internal structure such as pipe 21, drain pan 22, and fan 23 arranged as shown with a dashed line in Fig. 3 can readily visually be checked through side panel 5 formed from the translucent member.

[0023] Pipe 21, drain pan 22, and fan 23 shown in Figs. 2 and 3 are formed from the translucent members. For example, a member made of transparent resin or a member made of glass is employed as the translucent member. A member made of acrylic or polycarbonate is employed as the member made of resin. According to such a construction, in indoor unit 1, the inside of the internal structure itself such as the inside of pipe 21, a reservoir in drain pan 22, and a front surface and a rear surface of fan 23 can also be seen through. A person in the indoor space where indoor unit 1 is provided can thus readily visually check the sanitation state such as contamination in the inside of pipe 21, drain pan 22, and fan 23.

[0024] At least one of decorative panel 2, filter panel 7, and side panel 5 should only be formed from the translucent member. At least one of pipe 21, drain pan 22, and fan 23 should only be formed from the translucent member. In order to more readily visually check the sanitation state such as contamination in the inside of indoor unit 1, the translucent member is preferably used for more constituent elements.

[0025] The first embodiment can obtain also an effect as follows. In indoor unit 1, a user of and a visitor to the space where indoor unit 1 is provided can readily check the sanitation state of the inside of indoor unit 1, and hence a level of sanitation management by an owner of the space where indoor unit 1 is provided can be estimated. When the user of and the visitor to the space where indoor unit 1 is provided are able to estimate the sanitation management level, provision of indoor unit 1 even with some cost being spent can be a value newly offered by the owner of the space who desires to appeal the high level of sanitation management.

[0026] Since the state of the internal structure of indoor unit 1 can readily visually be checked, the internal state of indoor unit 1 including a drive component such as fan 23, a mechanical component such as pipe 21 through which refrigerant passes, and refrigerant itself which cannot be seen by a general person in a conventional indoor unit can be provided as an object to be viewed. Indoor unit 1 can thus allow a person to see and enjoy such an apparatus as an indoor unit to which attention has conventionally had to be paid not to interfere design.

[0027] Since the state of the internal structure of indoor unit 1 can readily visually be checked, clogging of filter 9 can be avoided, and reduction in power consumption and suppression of lowering in efficiency of heat exchange of fan 23 owing to reduction in increase in air

passage resistance can be achieved to thereby reduce power consumption. Since the state of the internal structure of indoor unit 1 can readily visually be checked, leakage of drainage from drain pan 22 or the like, emergence of bacteria, risk of infection by viruses or bacteria, and generation of odors can be avoided. The state of the internal structure of indoor unit 1 can readily visually be checked.

10 Second Embodiment.

[0028] A configuration for making determination as to necessity of maintenance of indoor unit 1 in an air-conditioning system including indoor unit 1 including the translucent member as shown in the first embodiment will be described in a second embodiment.

[Configuration of Air-Conditioning System 500]

[0029] Fig. 4 is a front view of a control panel apparatus 10 included in an air-conditioning system 500 in the second embodiment. Control panel apparatus 10 is an operation apparatus in a form of a panel on which a control setting value such as temperature setting, a wind level, and a wind direction in connection with indoor unit 1 can be controlled, and includes an operation portion 17 formed from an operation button and the like and a display 11 formed from a liquid crystal display. On display 11, other than the setting values of the temperature setting, the wind level, and the wind direction, a number of an indoor unit ("indoor unit 002" in the figure) to be operated and a two-dimensional code 12 are shown. Two-dimensional code 12 shows information for identifying a type of indoor unit 1 such as a model of indoor unit 1.

[0030] Indoor unit 1 to be operated can be selected by performing an operation onto operation portion 17 on control panel apparatus 10. When a plurality of indoor units 1 are provided indoors, indoor unit 1 to be operated can be changed by performing an operation onto operation portion 17, and the number of the selected indoor unit and two-dimensional code 12 corresponding to the selected indoor unit are shown on display 11. Two-dimensional code 12 is a code to show information for connection to a web site provided by a server (a server 14 in Fig. 6) to make determination as to necessity of maintenance of indoor unit 1. Two-dimensional code 12 corresponding to indoor unit 1 may be shown on a surface of indoor unit 1 or shown by being printed on a paper medium and attached to indoor unit 1 or an area therearound.

[0031] Fig. 5 is a diagram showing a construction of air-conditioning system 500 in the second embodiment. Referring to Fig. 5, air-conditioning system 500 includes indoor unit 1 of air-conditioning apparatus 100 shown in the first embodiment, control panel apparatus 10 shown in Fig. 4, a portable terminal 13, and server 14. Portable terminal 13 performs an image pick-up function to pick up an image with a camera and a communication function

to communicate data through wireless communication. A person such as a manager of air-conditioning system 500 can use portable terminal 13 to pick up an image of indoor unit 1 and two-dimensional code 12 shown on display 11 of control panel apparatus 10 and to transmit data obtained by image pick-up to server 14.

[0032] Fig. 6 is a block diagram showing a configuration of portable terminal 13 and server 14 in the second embodiment. Referring to Fig. 6, portable terminal 13 includes a processor 131, a memory 132, a display 133, an image pick-up unit 134, and a communication unit 135.

[0033] Memory 132 includes a read only memory (ROM) and a random access memory (RAM). Processor 131 develops a program stored in the ROM on the RAM or the like and executes the program. The program stored in the ROM is a program where a processing procedure in control of portable terminal 13 is described. Processor 131 carries out various types of control in portable terminal 13 in accordance with such a program.

[0034] Portable terminal 13 is a terminal dedicated for air-conditioning system 500 and includes processor 131, memory 132, display 133, image pick-up unit 134, and communication unit 135. Display 133 also serves as an operation portion composed of a touch panel. Portable terminal 13 may be implemented by a general-purpose portable terminal, and in that case, a program to be executed in the dedicated terminal should be installed as an application program.

[0035] Server 14 includes a processor 141, a memory 142, a communication unit 143, an external storage 144, and a data input device 145. Memory 142 includes a ROM and a RAM. External storage 144 is implemented by a non-volatile external storage such as a hard disk and a flash memory. Processor 141 develops a program stored in the ROM on the RAM or the like and executes the program. Processor 141 develops a program stored in external storage 144 on the RAM or the like and executes the program. The programs stored in the ROM and external storage 144 are each a program where a processing procedure in various types of information processing executable by server 14 is described. Processor 141 performs various types of information processing in accordance with such a program and communicates information through communication unit 143, reads data stored in external storage 144, and writes data into external storage 144.

[0036] Data input device 145 is implemented by a device through which data can be inputted, such as a keyboard. Data inputted through data input device 145 may temporarily be stored in the RAM of memory 142 and used in a program executed by processor 141. The data may also temporarily be stored in the RAM of memory 142 and thereafter stored in external storage 144.

[0037] Portable terminal 13 and server 14 can wirelessly communicate data between communication unit 135 and communication unit 143, and for example, data is transmitted from portable terminal 13 to server 14.

[Flow of Checking as to Necessity of Maintenance of Indoor Unit 1 in Air-Conditioning System 500]

[0038] A flow of processing in the system when whether or not maintenance of indoor unit 1 is necessary is checked in air-conditioning system 500 will now be described. Fig. 7 is a flowchart showing a flow of processing in the system when whether or not maintenance of indoor unit 1 is necessary is checked in air-conditioning system 500.

[0039] When a manager of air-conditioning system 500 desires to check whether or not maintenance of indoor unit 1 is necessary, in step S1, the manager selects indoor unit 1 necessity of maintenance of which is to be checked, by performing an operation onto operation portion 17 of control panel apparatus 10. In step S1, when there are a plurality of indoor units 1 to be operated through control panel apparatus 10, one of the plurality of indoor units 1 is selected, and when there is a single indoor unit 1 to be operated through control panel apparatus 10, that single indoor unit 1 is selected.

[0040] In step S2, control panel apparatus 10 shows on display 11, two-dimensional code 12 corresponding to indoor unit 1 selected in step S1. In step S3, the manager uses portable terminal 13 to pick up an image of two-dimensional code 12 shown on display 11 of control panel apparatus 10 with the use of image pick-up unit 134.

[0041] In step S4, portable terminal 13 reads information on two-dimensional code 12 obtained by image pick-up in step S3 based on processing performed by processor 131, and it is connected via wireless communication to server 14 through communication unit 135 by access to an address on a web site for determination as to necessity of maintenance shown by two-dimensional code 12. Such a web site for determination as to necessity of maintenance is provided as processor 141 in server 14 performs processing for providing the web site for determination as to necessity of maintenance.

[0042] Two-dimensional code 12 shown on display 11 of control panel apparatus 10 is information for access to the web site for determination as to necessity of maintenance as described previously. Server 14 provides the web site for determination as to necessity of maintenance at an address different for each model of indoor unit 1. Information on two-dimensional code 12 shown on display 11 of control panel apparatus 10 is thus different for each type of the indoor unit necessity of maintenance of which is to be checked. The web site for determination as to necessity of maintenance may be provided for each model or for each group of models each including a plurality of models similar in structure.

[0043] In step S5, the manager operates display 133 also serving as the operation portion of portable terminal 13 to start up a management program stored in memory 132 for management of maintenance. Processor 131 may perform processing for automatically starting up the management program when it accesses the address of

the web site for determination as to necessity of maintenance.

[0044] In step S6, the manager uses image pick-up unit 134 of portable terminal 13 to pick up an image of indoor unit 1 selected in step S1. Image data of indoor unit 1 is thus stored in memory 132. Since the inside of indoor unit 1 can be seen through as described previously, the image picked up by portable terminal 13 shows the state on the outside and in the inside of indoor unit 1.

[0045] After the manager thus picks up the image of indoor unit 1, in step S7, the manager performs an operation onto portable terminal 13 in accordance with a request shown on display 133 of portable terminal 13 while the management program is running to transmit data required for checking as to necessity of maintenance such as the image data obtained by image pick-up from communication unit 135 to server 14. Data transmitted in step S7 includes not only the image data but also data indicating the owner of indoor unit 1, data indicating a model name of indoor unit 1, and data indicating timing of image pick-up. The data transmitted in step S7 includes not only such data but also data indicating position information such as an address of a location of image pick-up.

[0046] Server 14 receives at communication unit 143, the data transmitted from portable terminal 13. In step S8, processor 141 in server 14 inputs the image data received from portable terminal 13 into a trained model for making inference as to necessity of maintenance of indoor unit 1 based on the image data of indoor unit 1 to make determination as to necessity of maintenance of indoor unit 1.

[Determination as to Necessity of Maintenance in Server 14]

[0047] A method of making determination as to necessity of maintenance of indoor unit 1 in server 14 will now be described.

[0048] Fig. 8 is a block diagram showing a configuration used for making determination as to necessity of maintenance of indoor unit 1 in server 14. Server 14 includes, as the configuration to be used for determination as to necessity of maintenance of indoor unit 1, a training device 101, a trained model storage 301, and an inference device 201. Training device 101, inference device 201, and trained model storage 301 are implemented by software stored in memory 142 or external storage 144 and executed by processor 141.

[0049] Training device 101 generates a trained model and has the trained model stored in trained model storage 301. Inference device 201 uses the trained model stored in trained model storage 301 to infer whether or not maintenance of indoor unit 1 is necessary.

[0050] Fig. 9 is a diagram showing a configuration of training device 101. Training device 101 includes a data obtaining unit 102 and a model generator 103. Training device 101 is implemented by software stored in memory

142 or external storage 144 and executed by processor 141.

[0051] Data obtaining unit 102 obtains training data obtained by bringing image data of indoor unit 1 stored in external storage 144 in correspondence with data indicating whether or not maintenance is necessary (ground truth). Predetermined training data is stored as the training data in external storage 144. The training data is image data of indoor unit 1 and it is obtained by bringing a plurality image data sets different in sanitation state such as a degree of contamination in correspondence with the data indicating whether or not maintenance is necessary (ground truth) in connection with each of image data sets.

[0052] Predetermined data may be employed as the training data, or data added and updated by successive inputs as to whether or not maintenance is necessary (ground truth) from data input device 145 in connection with the image data of indoor unit 1 received from portable terminal 13 may be employed as the training data.

[0053] Model generator 103 generates a trained model to infer whether or not maintenance of indoor unit 1 is necessary, based on training data obtained by associating the image data of indoor unit 1 obtained by data obtaining unit 102 and whether or not maintenance is necessary (ground truth) with each other.

[0054] A known algorithm such as supervised learning, unsupervised learning, or reinforced learning can be employed as a training algorithm to be used by model generator 103. By way of example, a training algorithm to which a neural network is applied will be described below.

[0055] Fig. 10 is a diagram showing a configuration of a neural network. Model generator 103 learns whether or not maintenance of indoor unit 1 is necessary, for example, in accordance with a neural network model by what is called supervised learning. Supervised learning refers to such a technique to give a set of training data including inputs and results (labels) to training device 101 to learn characteristics in the training data and to infer the results from the inputs.

[0056] The neural network is composed of an input layer composed of a plurality of neurons, an intermediate layer (a hidden layer) composed of a plurality of neurons, and an output layer composed of a plurality of neurons. The intermediate layer may be composed of a single layer or at least two layers.

[0057] For example, in a case of a neural network including three layers, when a plurality of inputs are provided to the input layer (X1 to X3), values thereof are multiplied by a weight W1 (w11 to w16) and results of the multiplication are provided to the intermediate layer (Y1 to Y2). The results are further multiplied by a weight W2 (w21 to w26) and results of the multiplication are outputted from the output layer (Z1 to Z3). Results of output vary depending on values of weights W1 and W2.

[0058] The neural network generates a trained model for inference as to whether or not maintenance of indoor unit 1 is necessary, based on the image data of indoor unit 1 received from portable terminal 13 in air-condition-

ing system 500, in accordance with the training data obtained by data obtaining unit 102 by supervised learning.

[0059] In other words, the neural network is trained by adjustment of weights W1 and W2 such that results outputted from the output layer as a result of input of the image data of indoor unit 1 into the input layer are close to whether or not maintenance of indoor unit 1 is necessary (ground truth).

[0060] Model generator 103 generates and outputs the trained model by being trained as set forth above.

[0061] The trained model outputted from model generator 103 is stored in trained model storage 301.

[Procedure of Training by Training Device 101]

[0062] Fig. 11 is a flowchart showing a procedure of training by training device 101.

[0063] In step b 1, data obtaining unit 102 obtains, for example, the image data of indoor unit 1 stored in external storage 144 and data indicating whether or not maintenance of indoor unit 1 is necessary (ground truth).

[0064] In step b2, model generator 103 generates a trained model for inference as to necessity of maintenance of indoor unit 1 from the image data of indoor unit 1 based on the training data obtained by associating the image data of indoor unit 1 obtained by data obtaining unit 102 and whether or not maintenance is necessary (ground truth) with each other.

[0065] In step b3, the trained model generated by model generator 103 is stored in trained model storage 301.

[Configuration of Inference Device 201]

[0066] Fig. 12 is a diagram showing a configuration of inference device 201. Inference device 201 includes a data obtaining unit 202 and an inference unit 203. Information on whether or not maintenance is necessary inferred by inference device 201 is used for setting up a maintenance plan in a maintenance plan set-up unit 600. Inference device 201 and maintenance plan set-up unit 600 are implemented by software stored in memory 142 or external storage 144 and executed by processor 141.

[0067] Data obtaining unit 202 obtains the image data of indoor unit 1 received from portable terminal 13 of air-conditioning system 500.

[0068] Inference unit 203 uses the trained model stored in trained model storage 301 to infer whether or not maintenance of indoor unit 1 is necessary based on the image data of indoor unit 1 received from portable terminal 13 of air-conditioning system 500 obtained by data obtaining unit 202. Inference unit 203 can output to maintenance plan set-up unit 600, data indicating whether or not maintenance of indoor unit 1 is necessary that is inferred based on the image data of indoor unit 1, by inputting the image data of indoor unit 1 obtained by data obtaining unit 202 into the trained model.

[Procedure of Inference by Inference Device 201]

[0069] Fig. 13 is a flowchart showing a procedure of inference by inference device 201 and a procedure of set-up of a maintenance plan by maintenance plan set-up unit 600.

[0070] In step c1, data obtaining unit 202 obtains the image data of indoor unit 1 received from portable terminal 13 of air-conditioning system 500.

[0071] In step c2, inference unit 203 inputs the image data of indoor unit 1 obtained in step c1 into the trained model stored in trained model storage 301. In step c3, inference unit 203 infers, with the use of the trained model, whether or not maintenance of indoor unit 1 is necessary, based on the image data of indoor unit 1 obtained in step c1.

[0072] By way of example, in step c3, as inference as to necessity of maintenance, a location to be maintained and contents of maintenance works such as whether or not filter 9 should be cleaned, whether or not filter 9 should be replaced, whether or not drain pan 22 should be cleaned, whether or not the inside of the panel (decorative panel 2, filter panel 7, and/or side panel 5) should be cleaned, and whether or not the panel (decorative panel 2, filter panel 7, and/or side panel 5) should be replaced are estimated by inference. Depending on the state of contamination at the location estimated as the location to be maintained, timing of maintenance such as whether or not maintenance is necessary immediately or at which timing in the future maintenance will be necessary is estimated by inference.

[0073] In step c4, maintenance plan set-up unit 600 determines whether or not maintenance is necessary immediately based on a result of inference as to necessity of maintenance by inference unit 203 in step c3.

[0074] When it is determined in step c4 that maintenance is necessary immediately, in step c5, maintenance plan set-up unit 600 determines to send a maintenance worker to the location where air-conditioning system 500 including indoor unit 1 determined as requiring maintenance is located and the process proceeds to step c7. When it is determined to send the maintenance worker, contents of maintenance works estimated in step c3 are further determined as contents of works by the sent worker.

[0075] When it is determined in step c4 that maintenance is not necessary immediately, in step c6, maintenance plan set-up unit 600 determines timing in the future to do maintenance, and the process proceeds to step c7. For example, in step c6, timing of maintenance estimated in step c3 such as at which timing in the future maintenance will be necessary is determined as the timing to do maintenance in the future.

[0076] In step c7, maintenance plan set-up unit 600 sets up a maintenance schedule based on matters determined in step c5 or matters determined in step c6. In step c7, for example, when it is determined in step c5 to send a maintenance worker, a maintenance schedule as

to how many workers should be sent and how long working hours are scheduled is set up based on the determined contents of maintenance works. In step c7, for example, when timing to do maintenance in the future is determined in step c6, a maintenance schedule in accordance with the timing to do maintenance in the future is set up, for example, by securing the timing to do maintenance in the future or by notifying the owner of air-conditioning system 500 of the timing to do maintenance in the future.

[0077] Information on the maintenance schedule thus set up is transmitted to a maintenance service provider. The maintenance service provider may obtain information on the maintenance schedule thus set up, by establishing connection for communication to server 14. Such a maintenance service provider can check such information on the maintenance schedule and do maintenance.

[0078] In the procedure of inference by inference device 201 and the procedure for set-up of a maintenance plan by maintenance plan set-up unit 600 described above, the image data of indoor unit 1 received from portable terminal 13 is such image data as allowing checking of a state in the inside of indoor unit 1, and inference unit 203 inputs the image data of indoor unit 1 received from portable terminal 13 into the trained model to make inference as to necessity of maintenance of indoor unit 1 based on the image data of indoor unit 1 with the use of the trained model to thereby make determination as to necessity of maintenance of indoor unit 1. Therefore, the sanitation state of indoor unit 1 can readily be checked.

[0079] In the second embodiment, in addition to the effect as described previously, determination as to necessity of maintenance based on image data can be optimized. In the second embodiment, in addition to the effect as described previously, a frequency of maintenance and arrangement of a schedule to send maintenance in connection with the maintenance can be optimized. By optimizing the frequency of maintenance and arrangement of the schedule to send maintenance, unnecessary maintenance can be reduced, cost for maintenance born by the owner of air-conditioning system 500 and the maintenance service provider can be reduced, and competitiveness in terms of maintenance cost in the maintenance service provider can be improved.

[0080] Other effects obtained by the structure of indoor unit 1 to allow the state of the internal structure to more readily visually be checked are as follows. For example, a fault and a failure that have not conventionally been confirmed unless such exterior objects as various panels are removed, such as physical damage to indoor unit 1 or displacement of a position where a structure in indoor unit 1 is fixed, can be estimated in advance based on the image data obtained by image pick-up of indoor unit 1. Therefore, a repair item such as "repair completed on the first visit" can be included in items of a maintenance service.

[0081] In order to avoid erroneous use of air-conditioning system 500 by a third party who is not supposed to

use air-conditioning system 500, for example, entry of a password may be requested in a stage preceding an operation to show two-dimensional code 12 or at the time of connection to a web site, and based on password authentication, only when a correct password is entered, various types of processing for determining whether or not maintenance of indoor unit 1 in air-conditioning system 500 is necessary may be performed.

10 Modification.

[0082]

15 (1) Training device 101 and inference device 201 may be located on a cloud server.

(2) In the second embodiment described previously, an example of application of supervised learning to the training algorithm to be used by model generator 103 is described, however, limitation as such is not intended. Other than supervised learning, reinforced learning, unsupervised learning, or semi-supervised learning can also be applied to the training algorithm.

(3) Model generator 103 may use training data created based on image data of indoor units 1 of a plurality of air-conditioning systems 500 to learn whether or not maintenance of indoor unit 1 is necessary. Model generator 103 may use training data created based on image data of indoor units 1 of a plurality of air-conditioning systems 500 that operate in an identical area to learn whether or not maintenance of indoor unit 1 is necessary. Model generator 103 may use training data created based on image data of indoor units 1 of a plurality of air-conditioning systems 500 that operate independently in different areas to learn whether or not maintenance of indoor unit 1 is necessary.

(4) Model generator 103 can also add or remove air-conditioning system 500 to obtain training data in midway. Furthermore, training device 101 which has learned whether or not maintenance is necessary in connection with a certain air-conditioning system 500 may be applied to a training device of an air-conditioning system different from the former air-conditioning system to learn again whether or not maintenance is necessary in connection with such another air-conditioning system for update.

(5) Deep learning to learn extraction of a feature value itself can also be employed as the training algorithm where model generator 103 is used, and machine learning may be done in accordance with other known methods such as genetic programming, functional logic programming, or a support vector machine.

(6) Though inference device 201 makes inference as to necessity of maintenance based on the image data obtained by data obtaining unit 202 with the use of the trained model in the embodiment, limitation as such is not intended. The inference device may make

inference as to necessity of maintenance based on input data obtained by the data obtaining unit based on rule-based reasoning or case-based reasoning. (7) Indoor unit 1 in the embodiment may allow works for mount and removal of a panel to be more efficient by implementing a panel such as a decorative panel provided as an exterior member, as a mount unit for mounting a decorative panel in Japanese Patent No. 5950877. For example, the mount unit for mounting a decorative panel on an air-conditioning apparatus main body may be composed of two components of a panel mount screw and a panel mount fitting having a screw engagement hole with a head of the panel mount screw being oriented downward, the panel mount fitting being provided with a claw that is fitted into a claw engagement hole in the panel without the panel mount fitting itself being dropped off from the panel.

[Summary of Embodiments]

[0083] The embodiments described above will be described again with reference to the drawings.

[0084] The present disclosure relates to air-conditioning apparatus 100 including indoor unit 1. Indoor unit 1 includes decorative panel 2 as the first panel provided in the front surface where air outlet 4 is provided in indoor unit 1, filter panel 7 as the second panel to which filter 9 for air inlet 3 is attached, filter panel 7 being provided in the front surface of indoor unit 1, and side panel 5 as the third panel provided in the side surface of indoor unit 1. At least one of decorative panel 2, filter panel 7, and side panel 5 is formed from a translucent member.

[0085] According to such a construction, the inside of indoor unit 1 can be seen through these exterior members. Thus, a person in the indoor space where indoor unit 1 is provided can thus readily visually check a sanitation state such as contamination in the inside of indoor unit 1 from the outside of indoor unit 1 from the lower surface side and the side surface side of indoor unit 1.

[0086] Preferably, indoor unit 1 further includes drain pan 22, pipe 21 through which refrigerant flows, and fan 23. At least one of drain pan 22, pipe 21, and fan 23 is formed from the translucent member. According to such a construction, the inside of the internal structure itself such as the inside of pipe 21, a reservoir in drain pan 22, and a front surface and a rear surface of fan 23 can also be seen through. According to such a construction, a person in the indoor space where indoor unit 1 is provided can thus readily visually check a sanitation state such as contamination in the inside of pipe 21, drain pan 22, and fan 23.

[0087] The present disclosure includes indoor unit 1 including such translucent members as decorative panel 2, filter panel 7, and side panel 5, the inside of which can be seen through the translucent members, control panel apparatus 10 as the display apparatus to show two-dimensional code 12 corresponding to indoor unit 1, port-

able terminal 13 as the terminal to pick up an image of two-dimensional code 12 shown on control panel apparatus 10, to pick up an image of the inside from the outside of indoor unit 1, and to transmit image data obtained as a result of image pick-up, and server 14 to make determination as to maintenance of indoor unit 1 based on the image data transmitted from portable terminal 13. Portable terminal 13 can communicate with server 14 based on two-dimensional code 12 the image of which has been picked up (step S4). Server 14 inputs the image data received from indoor unit 1 into a trained model for inference as to necessity of maintenance of indoor unit 1 based on the image data of the portable terminal 13 to make determination as to necessity of maintenance of the indoor unit (steps c2 and c3).

[0088] According to such a configuration, in server 14, the image data of indoor unit 1 received from portable terminal 13 is such image data as allowing checking of the state of the inside of indoor unit 1, and inference unit 203 inputs the image data of indoor unit 1 received from portable terminal 13 into the trained model to make inference as to necessity of maintenance of indoor unit 1 based on the image data of indoor unit 1 with the use of the trained model. The server thus makes determination as to necessity of maintenance of indoor unit 1. Therefore, the sanitation state of indoor unit 1 can readily be checked.

[0089] Preferably, server 14 estimates a location to be maintained in inference as to necessity of maintenance of indoor unit 1 (step c3). According to such a configuration, the location to be maintained can readily be estimated based on the image data of indoor unit 1 received from portable terminal 13.

[0090] Preferably, server 14 further estimates timing when maintenance is necessary based on the estimated location of maintenance in the inference as to necessity of maintenance of indoor unit 1, and makes determination as to necessity of maintenance in accordance with the estimated timing of maintenance (step c3). According to such a configuration, timing when maintenance is necessary can readily be estimated based on the image data of indoor unit 1 received from portable terminal 13.

[0091] Preferably, when server 14 determines that maintenance of indoor unit 1 is necessary, it determines contents of maintenance works for indoor unit 1 in accordance with the state of contamination of indoor unit 1 (step c3). According to such a configuration, contents of maintenance works for indoor unit 1 can readily be determined based on the image data of indoor unit 1 received from portable terminal 13.

[0092] Preferably, when server 14 determines that maintenance of indoor unit 1 is not necessary, it determines timing of maintenance in the future which will be necessary in indoor unit 1 based on the estimated timing of maintenance (step c6). According to such a configuration, timing of maintenance in the future which will be necessary in indoor unit 1 can readily be determined based on the image data of indoor unit 1 received from

portable terminal 13.

[0093] It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the terms of the claims rather than the description of the embodiments above and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0094] 100 air-conditioning apparatus; 1 indoor unit; 4 outlet; 2 decorative panel; 7 filter panel; 5 side panel; 22 drain pan; 23 fan; 21 pipe; 10 control panel apparatus; 11 display; 13 portable terminal; 14 server

Claims

1. An air-conditioning apparatus comprising:

an indoor unit, wherein
the indoor unit comprises

a first panel provided in a front surface of the indoor unit, an air outlet being provided in the front surface,
a second panel provided in the front surface of the indoor unit, a filter for an air inlet being attached to the second panel, and
a third panel provided in a side surface of the indoor unit, and

at least one of the first panel, the second panel, and the third panel is formed from a translucent member.

2. The air-conditioning apparatus according to claim 1, wherein

the indoor unit further comprises

a drain pan,
a pipe through which refrigerant flows, and
a fan, and

at least one of the drain pan, the pipe, and the fan is formed from a translucent member.

3. An air-conditioning system comprising:

an indoor unit comprising a translucent member, inside of which can be seen through the translucent member;

a display apparatus to show two-dimensional code information corresponding to the indoor unit;

a terminal to pick up an image of the two-dimen-

sional code information shown on the display apparatus, to pick up an image of the inside from outside of the indoor unit, and to transmit image data obtained as a result of image pick-up; and a server to make determination as to maintenance of the indoor unit based on the image data transmitted from the terminal, wherein the terminal is permitted to transmit the image data obtained as a result of image pick-up to the server based on the two-dimensional code information obtained by image pick-up, and the server inputs the image data received from the indoor unit to a trained model for inference as to necessity of maintenance of the indoor unit based on the image data of the terminal to make determination as to necessity of maintenance of the indoor unit.

4. The air-conditioning system according to claim 3, wherein

the server estimates a location to be maintained, in the inference as to necessity of maintenance of the indoor unit.

5. The air-conditioning system according to claim 4, wherein

the server further estimates timing when maintenance is necessary based on the estimated location to be maintained in the inference as to necessity of maintenance of the indoor unit and makes determination as to necessity of maintenance in accordance with the estimated timing of maintenance.

6. The air-conditioning system according to claim 5, wherein

when the server determines that maintenance of the indoor unit is necessary, the server determines contents of works in maintenance of the indoor unit in accordance with a contamination state of the indoor unit.

7. The air-conditioning system according to claim 5, wherein

when the server determines that maintenance of the indoor unit is not necessary, the server determines timing of future maintenance which will be necessary for the indoor unit based on the estimated timing of maintenance.

FIG.1

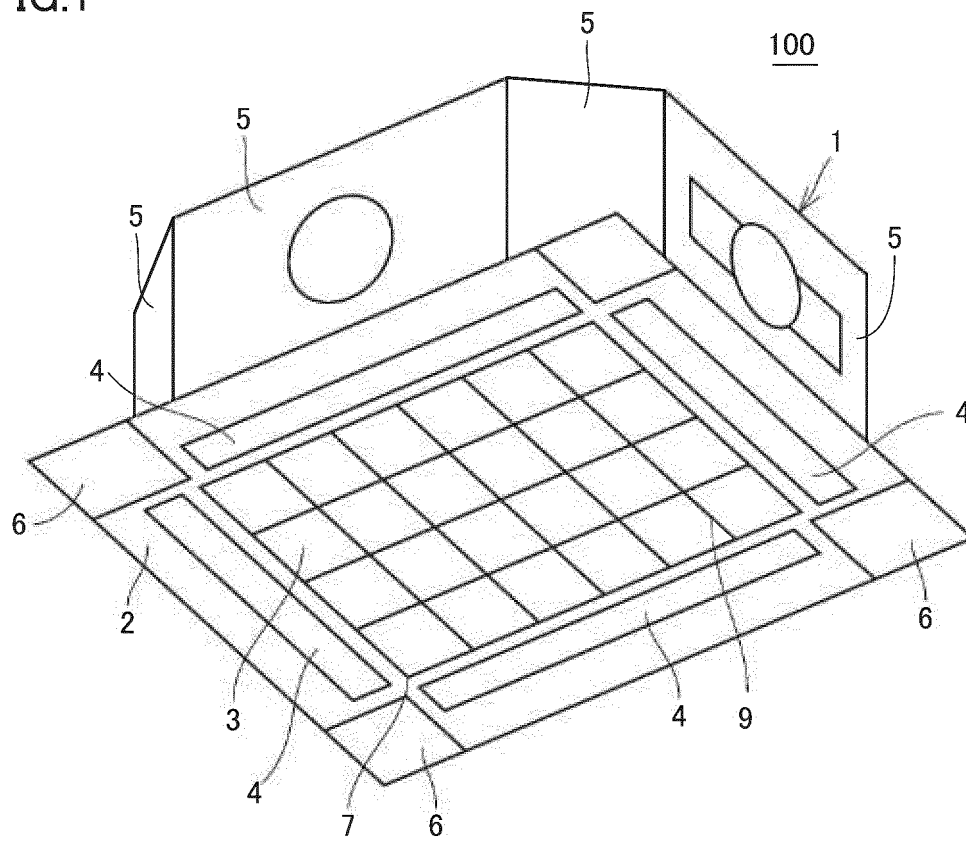


FIG.2

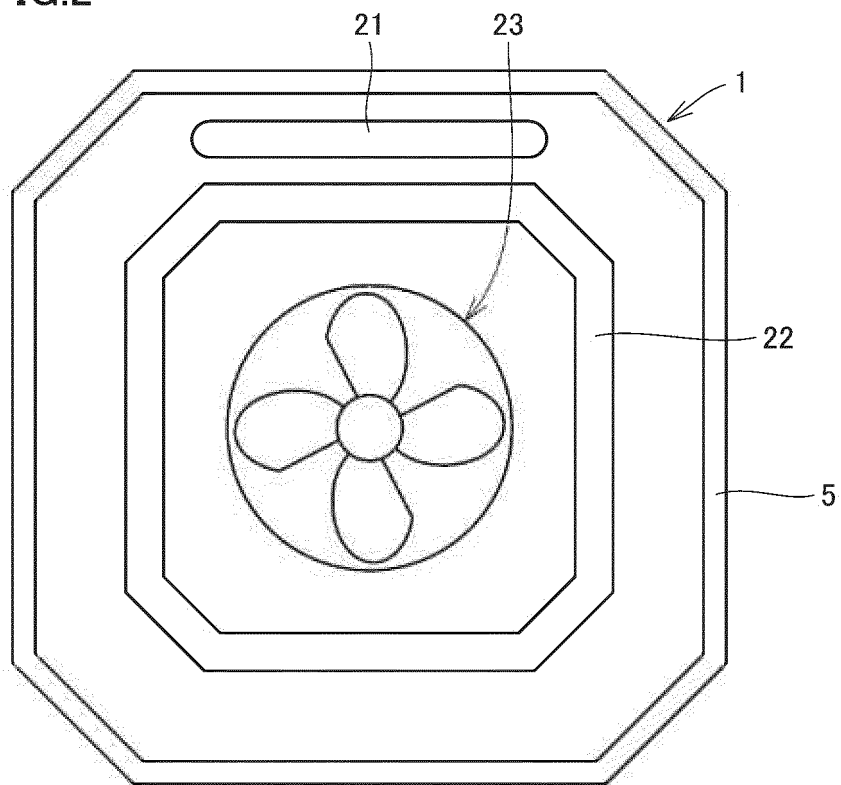


FIG.3

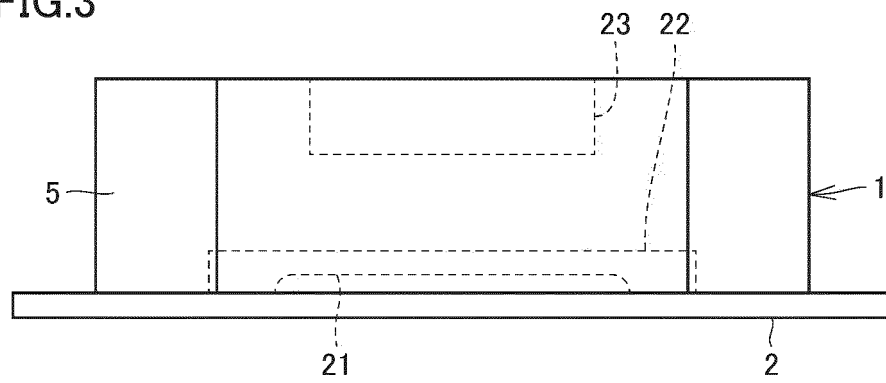


FIG.4

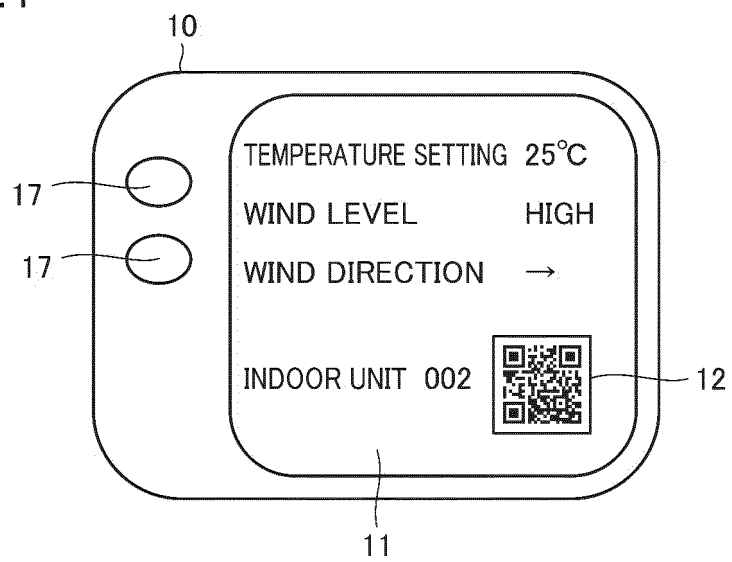


FIG.5

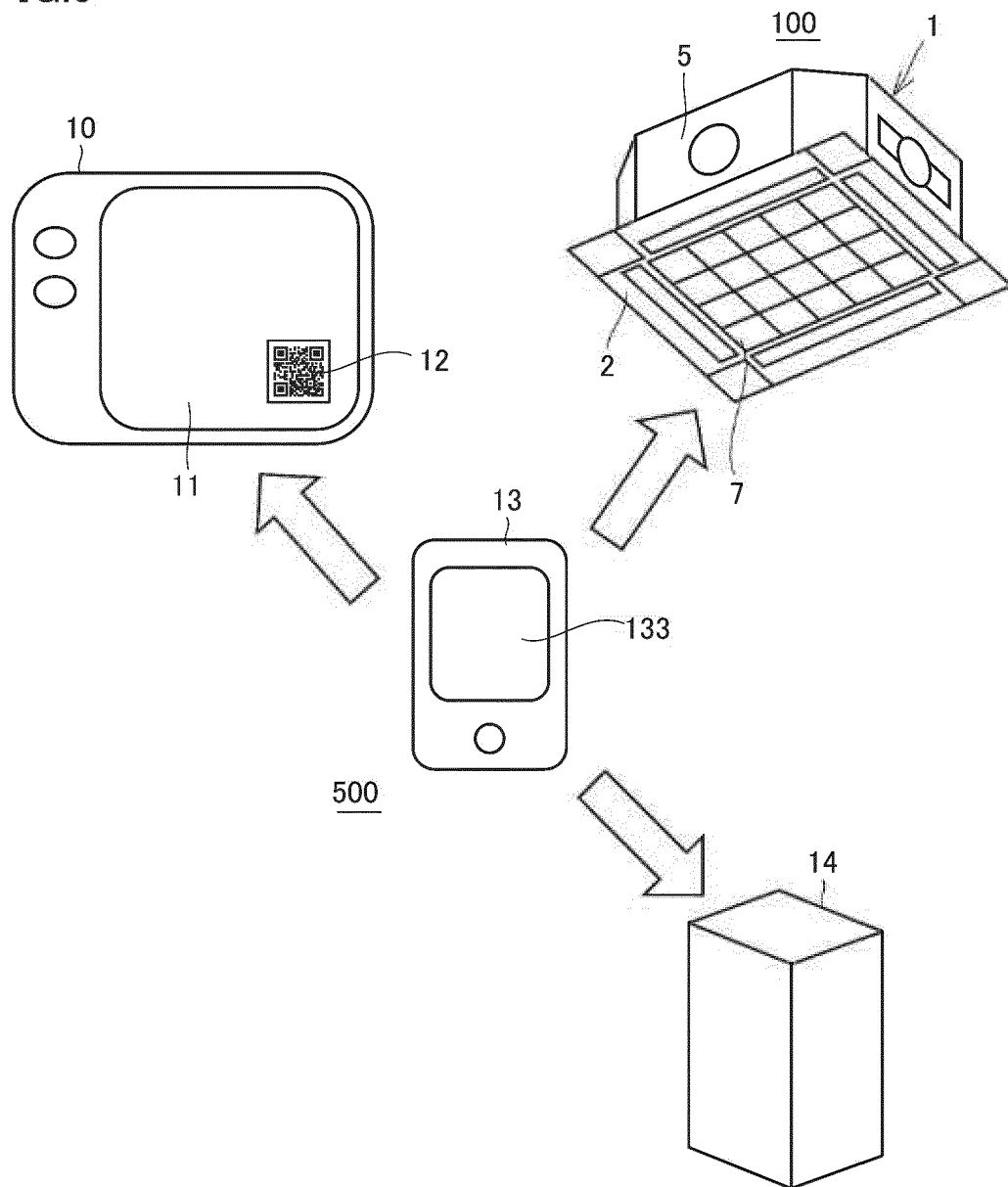


FIG.6

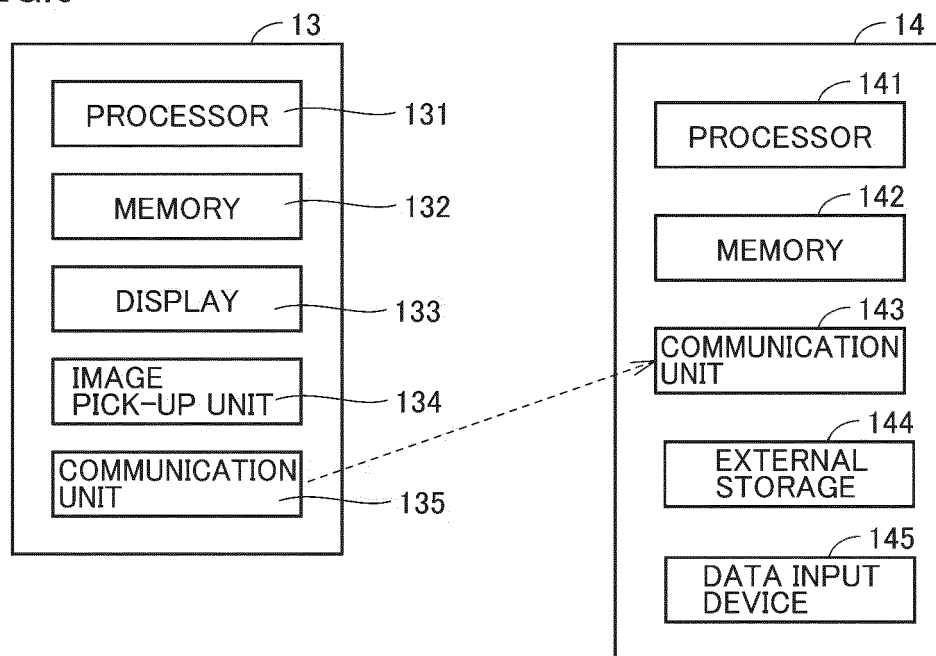


FIG.7

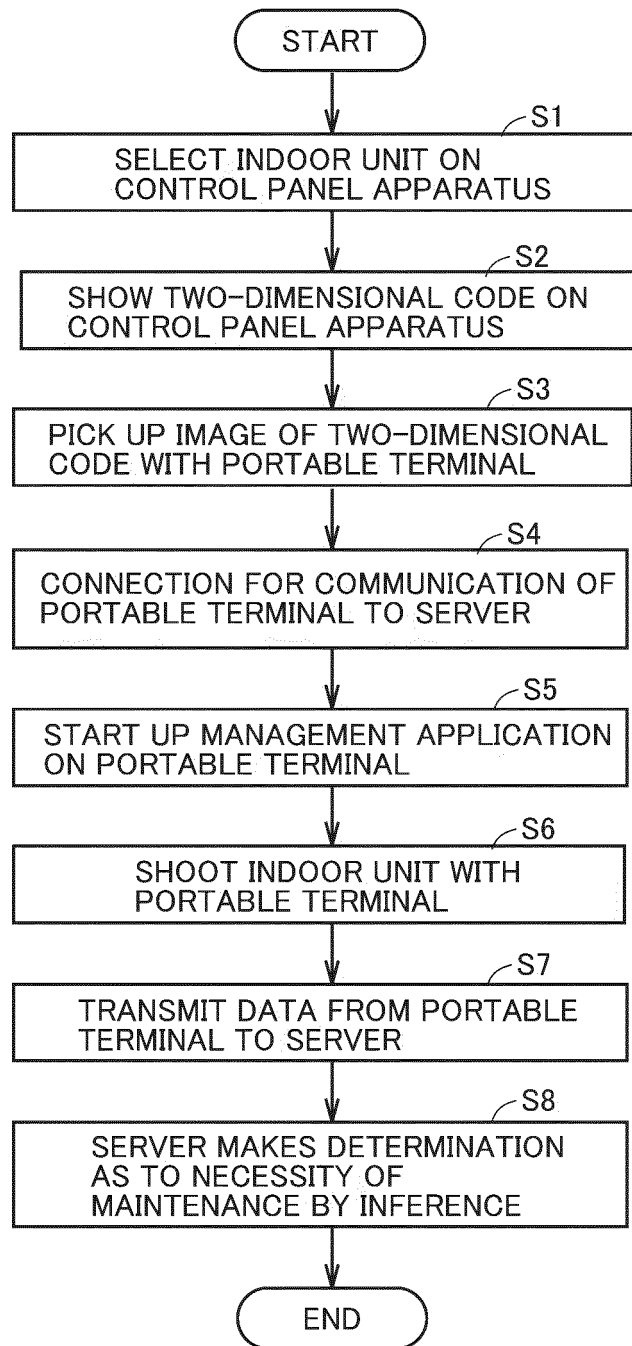


FIG.8

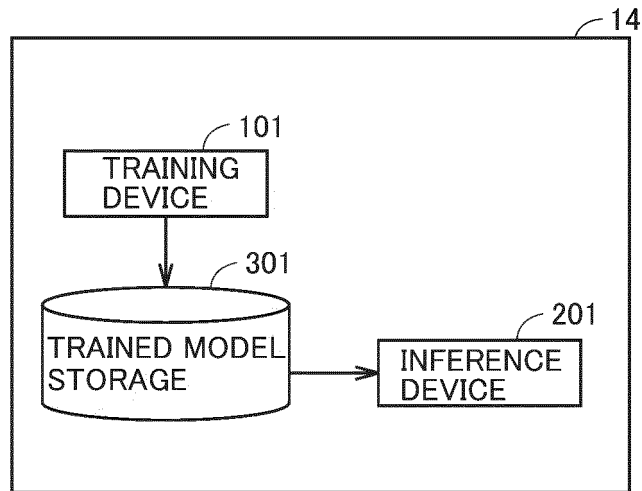


FIG.9

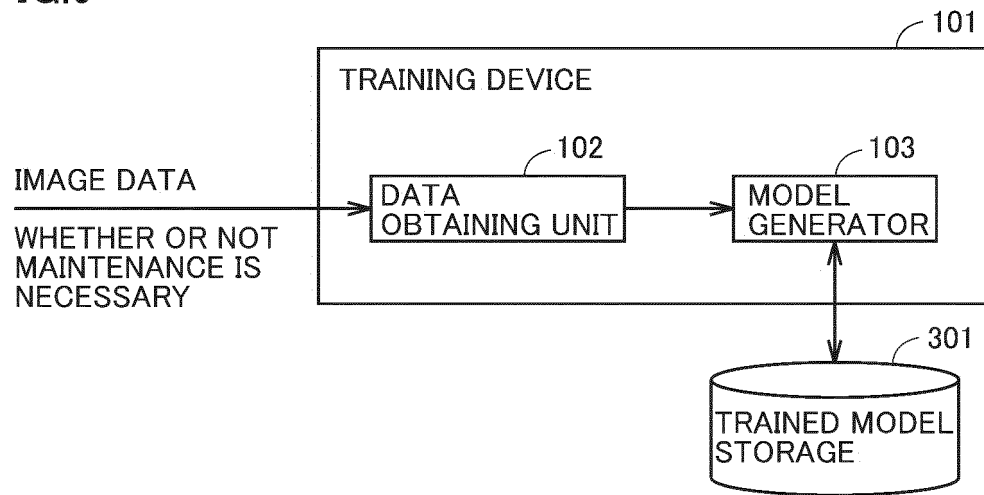


FIG.10

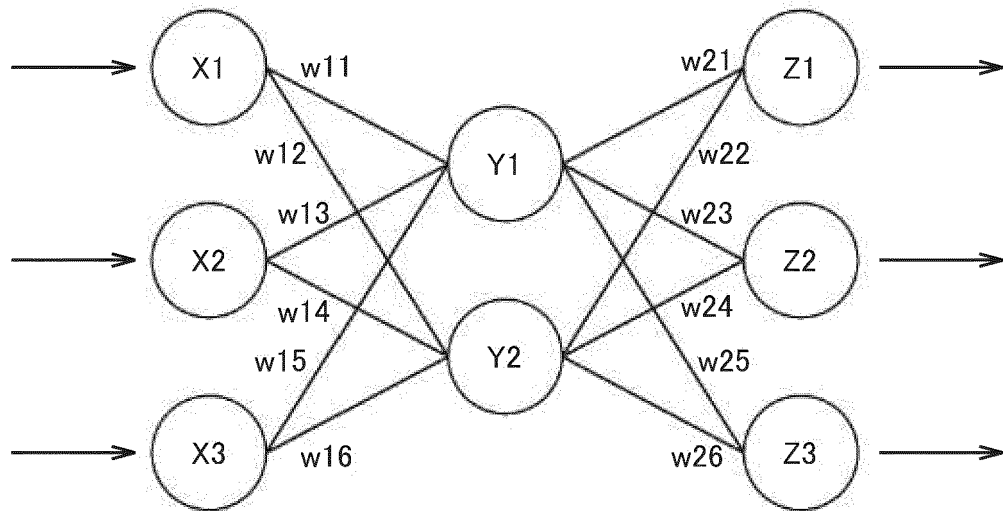


FIG.11

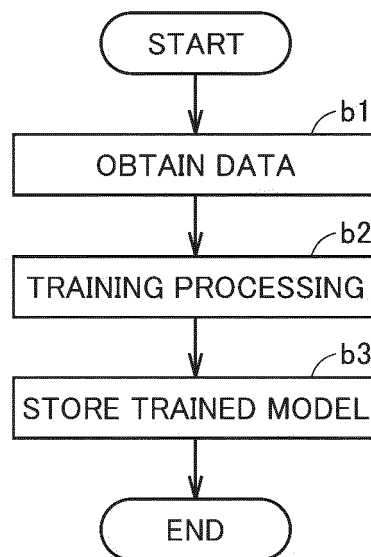


FIG.12

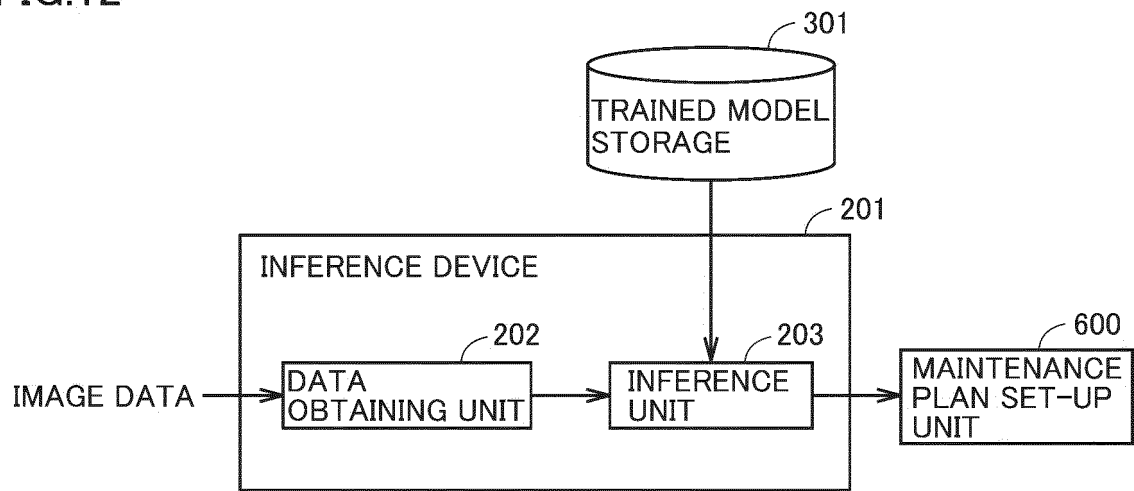
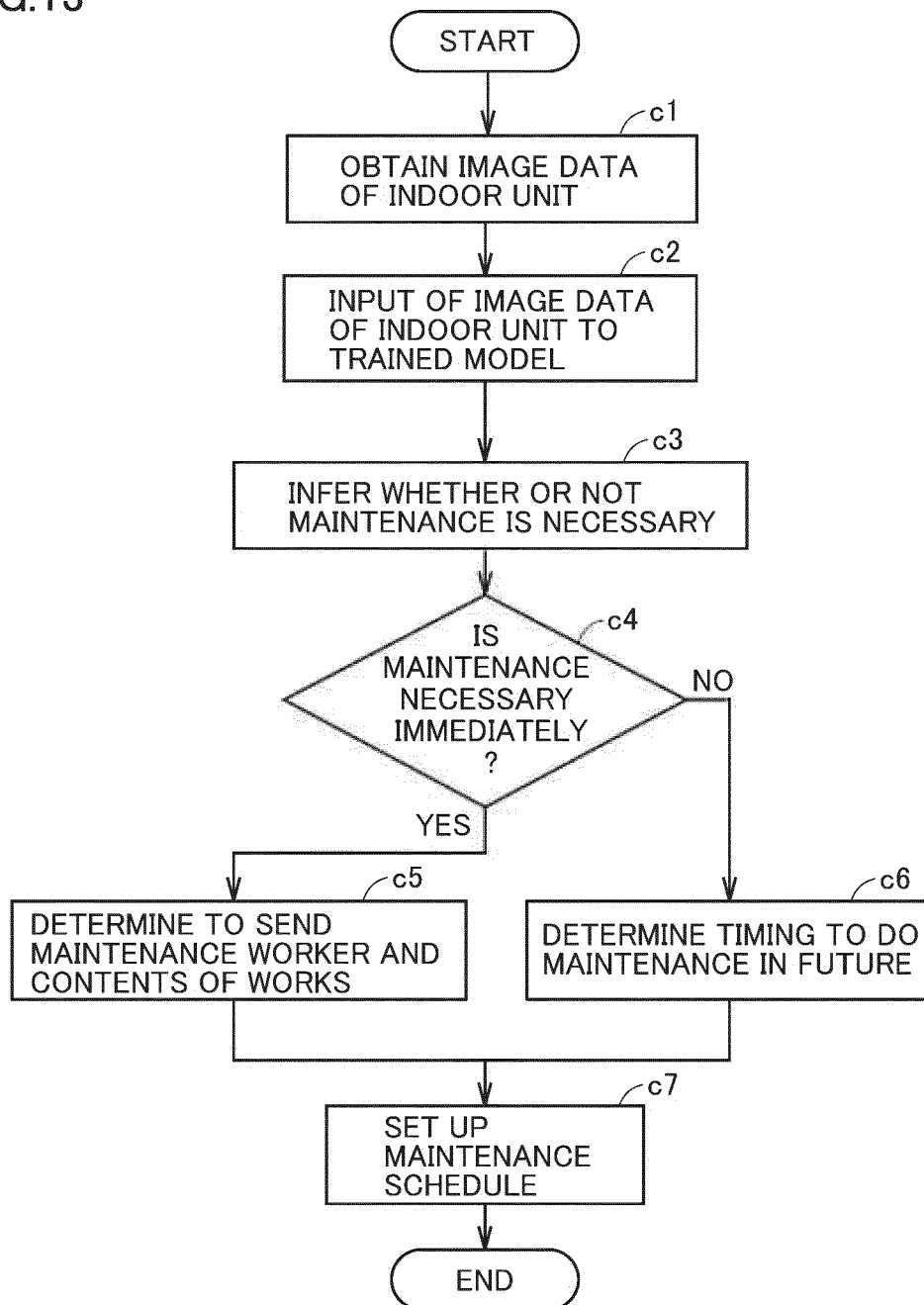


FIG.13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/015711

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/38(2018.01)i; F24F 11/58(2018.01)i; F24F 13/22(2006.01)i; F24F 13/20(2006.01)i

FI: F24F1/0007 361D; F24F1/0007 401B; F24F1/0007 401Z; F24F11/38; F24F11/58

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F11/38; F24F11/58; F24F13/22; F24F13/20

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 020346/1982 (Laid-open No. 123222/1958) (KIMURA KOHKI CO) 22 August 1983 (1983-08-22) specification, page 2, line 17 to page 3, line 16	1-2 3-7
Y A	JP 2002-243254 A (MITSUBISHI ELECTRIC CORP) 28 August 2002 (2002-08-28) paragraphs [0028]-[0030]	1-2 3-7
Y	JP 2013-133982 A (DAIKIN INDUSTRIES LTD) 08 July 2013 (2013-07-08) paragraph [0053]	2

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

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search
10 May 2021 (10.05.2021)Date of mailing of the international search report
18 May 2021 (18.05.2021)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/015711

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 06-307742 A (SANYO ELECTRIC CO LTD) 01 November 1994 (1994-11-01) paragraphs [0021], [0027]	2
Y	JP 2012-215375 A (WAKASAWAN ENERG KENKYU CENTER) 08 November 2012 (2012-11-08) paragraphs [0002], [0045]	2
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A	JP 3070226 U (SHIN SETSUBI KOGYO KK) 28 July 2000 (2000-07-28)	1-7
A	JP 04-278127 A (HITACHI LTD) 02 October 1992 (1992-10-02)	1-7
A	JP 2020-139803 A (DAIKIN IND LTD) 03 September 2020 (2020-09-03)	3-7
A	JP 2020-139665 A (DAIKIN IND LTD) 03 September 2020 (2020-09-03)	3-7

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2021/015711

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JP 2020-139803 A	03 Sep. 2020	(Family: none)	
JP 2020-139665 A	03 Sep. 2020	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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- JP 5950877 B [0082]