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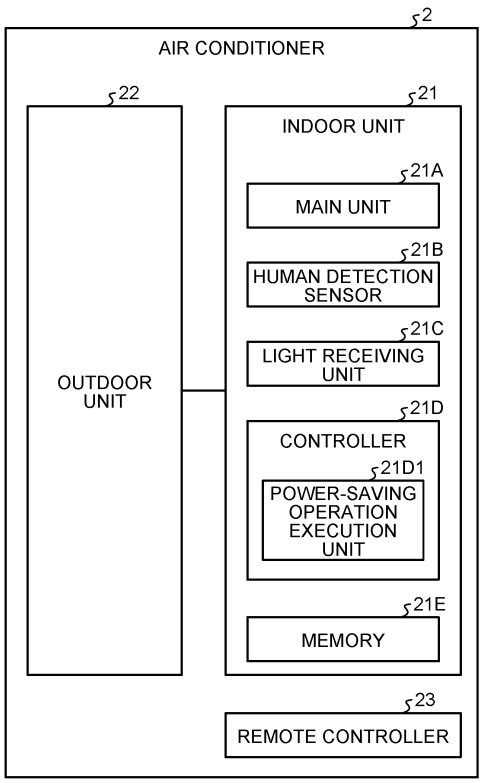
(54) **AIR CONDITIONER AND AIR CONDITIONING SYSTEM**

(57) An air conditioner includes a human detection sensor that detects whether a human is present in an air conditioning space and a presence/non-presence predictor that predicts whether a human will be present in the air conditioning space. The air conditioner further includes a controller that, using results of detection by the human detection sensor and results of prediction by the presence/non-presence predictor, makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that of the air conditioning operation. As a result, it is possible to realize an appropriate power-saving operation.

FIG.2



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Description

Field

[0001] The present invention relates to an air conditioner and an air conditioning system.

Background

[0002] For example, a power-saving operation of an air conditioner that includes a human detection sensor that detects whether a human is present in an air conditioning space and that stops an air conditioning operation using results of detection by the human detection sensor has been proposed (for example, Patent Literature 1). In the air conditioner according to Patent Literature 1, for example, when no human in the air conditioning space is detected for a certain time as the results of detection by the human detection sensor, executing the power-saving operation makes it possible to reduce the power consumption of an air conditioning operation.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Laid-open Patent Publication No. 2016-17663

Summary

Technical Problem

[0004] As for the conventional air conditioner, the case where, although a human is present in an air conditioning space, it is falsely detected that no human is present is assumed. The case of false detection includes, for example, the case where no human is present when a human is present outside a detection area of a human detection sensor in the air conditioning space and the case where, when the state where a human does not move continues although the human is present in the air conditioning space, it is detected that no human is present. For example, when the human detection sensor is an infrared sensor and the temperature of the air conditioning space is a temperature close to a human body temperature, it is not possible to detect presence of a human in some cases. As a result, the conventional air conditioner has a problem in that, when it is falsely detected that no human is present, the air conditioner executes the power-saving operation even though a human is present in the air conditioning space. Alternatively, there is a problem in that, even though no human is present in the air conditioning space, it is falsely detected that a human is present and the air-conditioning operation is continued.

[0005] In other words, in the conventional air conditioner, when the power-saving operation is executed or is not executed only depending on the result of detection by the human detecting sensor, it is not possible to realize an appropriate power-saving operation.

[0006] In view of the above-described problem, an object of the present invention is to provide an air conditioner and an air conditioning system that make it possible to realize an appropriate power-saving operation.

Solution to Problem

[0007] According to an aspect of an embodiment, an air conditioner includes a human detection sensor, a presence/non-presence predictor and a controller. The human detection sensor detects whether a human is present in an air conditioning space. The presence/non-presence predictor predicts whether a human will be present in the air conditioning space. The controller, using results of detection by the human detection sensor and results of prediction by the presence/non-presence predictor, makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that of the air conditioning operation.

Advantageous Effects of Invention

[0008] According to the air conditioner of the present invention, in one aspect, it is possible to realize an appropriate power-saving operation according to a state of presence or non-presence of a human.

Brief Description of Drawings

[0009]

FIG. 1 is an illustration illustrating an example of an air conditioning system of Embodiment 1.
FIG. 2 is a block diagram illustrating an example of a configuration of an air conditioner.
FIG. 3 is an illustration illustrating an example of a temperature shifting method in a first power-saving operation in a cooling mode.
FIG. 4 is an illustration illustrating an example of the temperature shifting method in the first power-saving operation in a dehumidifying mode.
FIG. 5 is an illustration illustrating an example of the temperature shifting method in the first power-saving operation in a heating mode.
FIG. 6 is a block diagram illustrating an example of a configuration of a communication adaptor.
FIG. 7 is an illustration illustrating an example of results of predicting presence or non-presence.
FIG. 8 is a block diagram illustrating an example of a configuration of a server device.
FIG. 9 is an illustration illustrating an example of data that is used to generate a presence/non-presence pattern.
FIG. 10 is an illustration illustrating an example of a

presence/non-presence pattern of a user.

FIG. 11 is a flowchart illustrating an example of processing operations performed by a CPU of a server device involved in a generating process of generating the presence/non-presence pattern.

FIG. 12 is a flowchart illustrating an example of processing operations performed by the CPU of the server device involved in an updating process of updating the presence/non-presence pattern.

FIG. 13 is a flowchart illustrating an example of processing operations performed by a controller of indoor unit involved in a power-saving process.

FIG. 14 is a block diagram illustrating an example of a configuration of an air conditioner of Embodiment 2. Description of Embodiments

[0010] Embodiments of an air conditioner and an air conditioning system disclosed in the preset application will be described in detail below according to the drawings. Note that the embodiments do not limit the disclosed technique. Each embodiment described below may be modified as appropriate in a range where no inconsistency is caused.

[First Embodiment]

<Configuration of Air Conditioning System>

[0011] FIG. 1 is an illustration illustrating an example of an air conditioning system 1 of Embodiment 1. The air conditioning system 1 illustrated in FIG. 1 includes an air conditioner 2, a communication adapter 3, a router 4, a server device 5, a relay device 6, a terminal device 7, and a communication network 8.

<Configuration of Air Conditioner>

[0012] FIG. 2 is a block diagram illustrating an example of a configuration of the air conditioner 2. The air conditioner 2 illustrated in FIG. 2 includes indoor unit 21, an outdoor unit 22, and a remote controller 23. The indoor unit 21, for example, is arranged indoors and is part of the air conditioner 2 that heats or cools the air of the inside that is an air conditioning space. For example, each air conditioning space, such as a living room or a bedroom, is equipped with the indoor unit 21. The indoor unit 21 includes a main unit 21A, a human detecting sensor 21B, a light receiving unit 21C, a controller 21D, and a memory 21E. The main unit 21A is equipped with an indoor fan and an indoor heat exchanger that are not illustrated in the drawings and the indoor air on which the indoor heat exchanger has performed heat exchange with a refrigerant that is supplied from the outdoor unit 22 is blown out by the indoor fan so that indoor heating, cooling, and dehumidifying, etc., are performed. The human detection sensor 21B detects whether a human is present in the air conditioning space. The human detection sensor 21B is, for example, a pyroelectric sensor using infrared light. When the air conditioner 2 is connected to a commercial power after being set and power is supplied, the human detection sensor 21B starts an operation of detecting whether a human, which is not limited to a specific person, is present in a sensor area in the air conditioning space. Note that, thereafter, unless power supply to the air conditioner 2 is stopped, whether a human is present in the air conditioning space is kept detected regardless whether the air conditioner 2 is operated or stopped. The light receiving unit 21C receives light of a command signal from the remote controller 23 and transmits the received command signal to the controller 21D. The memory 21E is, for example, a storage unit that stores various types of information. The controller 21D controls the entire indoor unit 21. The controller 21D executes various types of commands based on command signals. The outdoor unit 22, for example, is equipped with an outdoor fan, a compressor, etc. The remote controller 23 is a remote operation unit that remotely operates the indoor unit 21 according to an operation of a user.

[0013] Using results of detection by the human detection sensor 21B and results of prediction by a presence/non-presence predictor 34E to be described below, the controller 21D makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that of the air conditioning operation. The results of prediction by the presence/non-presence predictor 34E are information obtained by accumulating results of predicting presence or non-presence of the specific user in the air conditioning space on every 10 minutes in 24 hours, which are results acquired from the presence/non-presence predictor 34E in a communication adapter 3 to be described below. On the other hand, results of detection by the human detection sensor 21B are results of detecting presence or non-presence of a human who is present in the sensor area in the air conditioning space. The air conditioning operation is a normal air conditioning operation of changing the room temperature in the air conditioning space to a set temperature in, for example a cooling mode, a heating mode, or a dehumidifying mode.

[0014] When the human detection sensor 21B detects that a human is present during execution of the power-saving operation, the controller 21D determines that a human is present in the air conditioning space and restarts the air conditioning operation. Although the details will be described below, the controller 21D stores the results of predicting whether the user will be present at a given time, refers to results of prediction by the presence/non-presence predictor 34E from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when the results of prediction indicate that a human is present, the controller 21D determines that the user will be present in the air conditioning space and keeps the air conditioning operation. Specifically, the controller 21D refers to results of prediction by the pres-

ence/non-presence predictor 34E on a given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction indicate presence of a human according to the referred results of prediction, the controller 21D determines that the user will be present in the air conditioning space and keeps the air conditioning operation.

[0015] The controller 21D refers to the results of prediction by the presence/non-presence predictor 34E from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when the results of prediction indicate non-presence of a human, the controller 21D determines that the user will not be present in the air conditioning space and makes a switch from the air conditioning operation to the power-saving operation. Specifically, the controller 21D refers to the results of prediction by the presence/non-presence predictor 34E on a given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the result of prediction contains non-presence of a human according to the referred results of prediction, the controller 21D determines that the user will not be present in the air conditioning space and makes a switch from the air conditioning operation to the power-saving operation.

[0016] The power-saving operation includes a first power-saving operation that prioritizes comfortableness to the user and a second power-saving operation prioritizing power-saving effects. The first power-saving operation is a power-saving operation that is selected in the case where presence of a human and non-presence of a human are mixed in the results of prediction on the given time and is a power-saving operation of changing in stages the set temperature of the air conditioning operation before the switch to the power-saving mode without stopping the air conditioning operation and of which power consumption is smaller than that in the air conditioning operation before the switch to the power-saving operation. The second power-saving operation is a power-saving operation that is selected when the results of prediction on the given time all indicate non-presence of a human and is a power-saving operation that prioritizes the power-saving effect more than comfortableness to the user by stopping the air conditioning operation. The first power-saving operation is a power-saving operation that prioritizes comfortableness more than the power-saving effect compared to the second power-saving operation.

[0017] The first power-saving operation is a power-saving operation of shifting the set temperature every 10 minutes in stages from the set temperature in the air-conditioning operation before a switch to the power-saving operation corresponding to each operation mode of the normal air-conditioning operation. Note that the operation mode is, for example, the cooling mode, the heating mode, the dehumidifying mode, or the like. Thus, the temperature shifting method of the first power-saving operation differs in each operation mode.

[0018] FIG. 3 is an illustration illustrating an example of the temperature shifting method of the first power-saving operation in the cooling mode. When the human detection sensor 21B detects that no human is present at a time A in the cooling mode, the controller 21D changes the set temperature to Ts+T1, changes the set temperature to (Ts+T1)+T2 at a time B after an elapse of a time t1 from the time A, changes the set temperature to (Ts+T1+T2)+T3 at a time C after an elapse of a time t2 from the time B, and changes the set temperature to (Ts+T1+T2+T3)+T4 at a time D after an elapse of a time t3 from the time C. In other words, in the cooling mode, for example, the controller 21D increases the set temperature every certain time in stages using Ts+T1+T2+T3+T4 as a maximum shift temperature of the set temperature. Note that each of the times t1, t2 and t3 is, for example, 10 minutes and each of shift temperatures at T1, T2, T3 and T4 is, for example, 0.5 degrees Celsius. The result of detection by the human detection sensor 21B keeps indicating non-presence from the time A to the time D. In other words, the temperature shift continues while the human detection sensor 21B does not detect presence of a human.

[0019] In other words, when the set temperature in the cooling mode in the first power-saving operation is Ts, for example, the controller 21D increases the set temperature by 0.5 degrees Celsius every 10 minutes in stages until the temperature increases from the set temperature Ts by 2 degrees Celsius to a maximum shift temperature. In the case where the set temperature reaches a cooling maximum temperature that can be set in the cooling mode, for example, 30 degrees when the set temperature is increased in stages, the controller 21D stops increasing the set temperature even when the set temperature has not reached the maximum shift temperature corresponding to an increase by two degrees Celsius.

[0020] In the first power-saving operation in the cooling mode, the cooling operation does not stop while the set temperature is increased in stages, which makes it possible to reduce the power consumption of the air conditioner 2 in stages without impairing comfortableness to the user.

[0021] FIG. 4 is an illustration illustrating an example of the temperature shifting method of the first power-saving operation in the dehumidifying mode. When the human detection sensor 21B detects that no human is present at a time E in the dehumidifying mode, the controller 21D changes the set temperature to Ts+T1 and changes the set temperature to (Ts+T1)+T2 at a time F after an elapse of a time t1 from the time E. In other words, in the dehumidifying mode, for example, the controller 21D increases the set temperature using Ts+T1+T2 as a maximum shift temperature of the set temperature. Note that the time t1 is, for example, 10

minutes and each of shift temperatures at T1 and T2 is, for example, 0.5 degrees Celsius. The result of detection by the human detection sensor 21B keeps indicating non-presence from the time E to the time F. In other words, the temperature shift keeps while the human detection sensor 21B does not detect presence of a human.

[0022] In other words, when the set temperature in the dehumidifying mode in the first power-saving operation is Ts, for example, the controller 21D increases the set temperature by 0.5 degrees Celsius every 10 minutes in stages until the temperature increases from the set temperature by 1 degree Celsius to a maximum shift temperature. In the case where the set temperature reaches a dehumidifying maximum temperature that can be set in the dehumidifying mode, for example, 30 degrees when the set temperature is increased in stages, the controller 21D stops increasing the set temperature even when the set temperature has not reached the maximum shift temperature corresponding to an increase by one degree Celsius.

[0023] In the first power-saving operation in the dehumidifying mode, the dehumidifying operation does not stop while the set temperature is increased in stages, which makes it possible to reduce the power consumption of the air conditioner 2 in stages without impairing comfortableness to the user.

[0024] FIG. 5 is an illustration illustrating an example of the temperature shifting method of the first power-saving operation in the heating mode. When the human detection sensor 21B detects that no human is present at a time G in the heating mode, the controller 21D changes the set temperature to Ts-T1, changes the set temperature to (Ts-T1)-T2 at a time H after an elapse of a time t1 from the time G, changes the set temperature to (Ts-T1-T2)-T3 at a time I after an elapse of a time t2 from the time H, changes the set temperature to (Ts-T1-T2-T3)-T4 at a time J after an elapse of a time t3 from the time I, changes the set temperature to (Ts-T1-T2-T3-T4)-T5 at a time K after an elapse of a time t4 from the time J, and changes the set temperature to (Ts-T1-T2-T3-T4-T5)-T6 at a time L after an elapse of a time t5 from the time K. In other words, in the heating mode, for example, the controller 21D reduces the set temperature every certain time in stages using Ts-T1-T2-T3-T4-T5-T6 as a maximum shift temperature of the set temperature. Note that each of the periods t1, t2, t3, t4, t5, t6... is, for example, 10 minutes and each of shift temperatures at T1, T2, T3, T4, T5, T6... is, for example, 0.5 degrees Celsius. The result of detection by the human detection sensor 21B keeps indicating non-presence from the time G to the time L. In other words, the temperature shift continues while the human detection sensor 21B does not detect presence of a human.

[0025] In other words, when the set temperature in the heating mode in the first power-saving operation is Ts, for example, the controller 21D reduces the set temperature by 0.5 degrees every 10 minutes in stages until the temperature decreases from the set temperature by 4 degrees Celsius to a maximum shift temperature. In the case where the set temperature reaches a heating minimum temperature that can be set in the heating mode, for example, 16 degrees when the set temperature is reduced in stages, the controller 21D stops reducing the set temperature even when the set temperature has not reached the maximum shift temperature corresponding to a decrease by four degrees Celsius.

[0026] In the first power-saving operation in the heating mode, the heating operation does not stop while the set temperature is reduced in stages, which makes it possible to reduce the power consumption of the air conditioner 2 in stages without impairing comfortableness to the user.

[0027] As illustrated in FIG. 2, the controller 21D includes a power-saving operation execution unit 21D1. The power-saving operation execution unit 21D1 makes a switch from the air-conditioning operation to any one of the first power-saving operation and the second power-saving operation based on the length of the time in which no human is present obtained from the results of prediction by the presence/non-presence predictor 34E. Note that the length of the time in which no human is present obtained from the results of prediction is, for example, a first given time, a second given time, or a third given time. The first given time is a time from a time at which the human detection sensor 21B detects that no human is present on which results of predicting presence or non-presence are referred, for example, 60 minutes. The second given time is a time until a switch to the second power-saving operation that is made after the result of detection by the human detection sensor 21B keeps indicating "non-presence" when the results of prediction on the first given time all indicate "presence" and the normal operation is kept, for example, 60 minutes from the time at which non-presence of a human is detected first (recently). The third given time is a time until a switch to the second power-saving operation that is made after the result of detection by the human detection sensor 21B keeps indicating "non-presence" when presence and non-presence are mixed in the results of prediction on the first given time and the first power-saving operation is performed, for example, 180 minutes from the time at which non-presence of a human is detected first (recently).

[0028] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E in the first given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction all indicate that no human is present according to the referred results of prediction, the power-saving operation execution unit 21D1 determines that the user will not be present in the air conditioning space during the first given time and makes a switch from the air conditioning operation to the second power-saving operation.

[0029] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E in the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when the results of prediction all indicate that a human is present, the power-saving operation execution unit 21D1 determines that the user will be present in the air conditioning space during the first given time and keeps the air conditioning operation without making a switch to the power-saving operation.

[0030] When the power-saving operation execution unit 21D1 keeps the air conditioning operation because the results of prediction performed after the human detection sensor 21B detects that no human is present all indicate presence and when the human detection sensor 21B detects that no human is present, in the case where it is kept detected that no human is present during the second given time from the time at which the non-presence is detected, the power-saving operation execution unit 21D1 determines that the user is not present in the air conditioning space. The power-saving operation execution unit 21D1 then makes a switch from the air conditioning operation to the second power saving operation.

[0031] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E in the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when presence of a human and non-presence of a human are mixed in the results of prediction, determines that there is a possibility that the user will be present in the air-conditioning space in the first given time and makes a switch from the air conditioning operation to the first power-saving operation.

[0032] Alternatively, the power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E on the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, for example, even when the presence/non-presence predictor 34E has no result of prediction because presence/non-presence patterns to be described below are being generated, determines that there is a possibility that the user will be present in the air-conditioning space and makes a switch from the air conditioning operation to the first power saving operation.

[0033] When the first power-saving operation is being executed because presence of a human and non-presence of a human are mixed in the results of prediction performed after the human detection sensor 21B detects that no human is present or the presence/non-presence predictor 34E has no result of prediction and when the human detection sensor detects that no human is present, in the case where it is kept detected that no human is present for a third given time, for example, 180 minutes from the time at which the no-presence is detected, the power-saving operation execution unit 21D1 determines that the user is not present in the air conditioning space. The power-saving operation execution unit 21D1 then makes a switch from the first power saving operation to the second power saving operation.

[0034] Back to FIG. 1, the communication adapter 3 has a communicating function of connecting the indoor unit 21 in the air conditioner 2 and the router 4 by wireless communication and a controlling function of performing AI (Artificial Intelligence) control on the indoor unit 21. The communication adapter 3 is arranged for every indoor unit 21. The router 4 is a device of an access point that connects the communication adapter 3 and the communication network 8 by wireless communication using, for example, a WLAN (Wireless Local Area Network), or the like, and that connects the terminal device 7 and the communication network 8 by wireless communication. The terminal device 7 is a communication terminal device, such as a smartphone of a user serving as, for example, a manager from among a plurality of users who uses the air conditioning system 1.

[0035] The communication network 8 is, for example, a communication network, such as the Internet. The server device 5 has a function of generating presence/non-presence patterns that are applied to the indoor unit 21 and a database that stores operation history data, or the like. Note that the server device 5, for example, is arranged in a data center. The relay device 6 is connected to the communication network 8 by communication and has a function of connecting to the server device 5 by communication. The relay device 6 transmits the operation history data that is used to generate or update presence/non-presence patterns that are applied the indoor unit 21 via the communication network 8, etc., from the communication adapter 3 to the server device 5. The relay device 6 transmits the presence/non-presence patterns that are generated or updated by the server device 5 to the communication adapter 3 via the communication network 8. Note that the relay device 6 is arranged in the data center, or the like.

[0036] The relay device 6 includes a first relay unit 6A, a second relay unit 6B, and a third relay unit 6C. The first relay unit 6A transmits various types of data relevant to presence/non-presence patterns (referred to as operation history data below) from the communication adapter 3 to the server device 5 via the communication network 8 and transmits the presence/non-presence pattern that is generated or updated by the server device 5 to the communication adapter 3 via the communication network 8. The second relay unit 6B acquires conditions for operating the indoor unit 21 (such as an operation mode of cooling or heating and a set temperature) that are set by the user using the terminal device 7 at the place where the user has gone and transmits the operation conditions to the indoor unit 21. The third relay unit 6C, for example, acquires external data, such as weather forecasts and

calendar information (mainly national holiday information) from the communication network 8, such as the Internet, and transmits the acquired external data to the server device 5. The third relay unit 6C transmits the external data to the communication adapter 3 via the communication network 8.

Configuration of Communication Adapter

[0037] FIG. 6 is a block diagram illustrating an example of a configuration of the communication adapter 3. The communication adapter 3 illustrated in FIG. 6 includes a first communication unit 31, a second communication unit 32, a storage unit 33, and a CPU (Central Processing Unit) 34. The first communication unit 31 is, for example, a communication IF (Interface), such as UART (Universal Asynchronous Receiver Transmitter), that makes a communication connection between the controller 21D in the indoor unit 21 and the CPU 34. The second communication unit 32 is, for example, a communication unit, such as a communication IF of a WLAN, or the like, that makes a communication connection between the router 4 and the CPU 34. The storage unit 33 includes, for example, a ROM (Read Only Memory) and a RAM (Random Access Memory) and stores various types of information, such as data and a program. The CPU 34 controls the entire communication adapter 3.

[0038] The storage unit 33 in the communication adapter 3 illustrated in FIG. 6 includes a history memory 33A, a presence/non-presence pattern memory 33B, a prediction result memory 33C, and an external memory 33D. The history memory 33A temporarily stores the operation history data that is acquired from the indoor unit 21. For example, the results of detection in every 10 minutes by the human detection sensor 21B on whether a human is present in the indoor space. The presence/non-presence pattern memory 33B stores the presence/non-presence patterns that are acquired from the server device 5.

[0039] The presence/non-presence pattern is, for example, a pattern that is generated by the server device 5 with respect to each day of week and that presents a tendency of presence and non-presence of the user in the air conditioning space, using results of detection by the human detection sensor 21B in the past, for example, results of detecting presence or non-presence in the past 30 days, day-of-week information, and national holiday information. In the embodiment, five types of presence/non-presence patterns are generated at maximum and presence/non-presence patterns are associated with the respective days of week such that it is possible to determine in what presence/non-presence pattern the user tends to behave in each day of week. For example, there are a tendency of behaving in Presence/non-presence pattern 1 on Monday and Tuesday and a tendency of behaving in Presence/non-presence pattern 2 on Wednesday and Thursday. There are a tendency of behaving in Presence/non-presence pattern 3 on Thursday and Friday, a tendency of behaving in Presence/non-presence pattern 4 on Saturday, and a tendency of behaving in Presence/non-presence Pattern 5 on Sunday. The results of detection by the human detection sensor 21B in the past 30 days are used when generating presence/non-presence patterns because of the following reasons. More results of detection by the human detection sensor 21B for generation of presence/non-presence patterns increases accuracy of prediction using the presence/non-presence patterns and thus it is preferable that results of detection by the human detection sensor 21B are as many as possible. On the other hand, for example, assume the case, where presence/non-presence patterns are generated using results of detection in the past 90 days such that many results of detection by the human detection sensor 21B are acquired. When the time in which the air conditioner 2 is set is the time when the summertime in which the cooling operation is performed frequently starts and or the time when the wintertime in which the heating operation is performed frequently starts, the summer time and the winter time go by while presence/non-presence patterns are generated and thus it is not possible to make predictions of behaviors of the user based on results of predicting whether the user will be present and a recommendation for the air-conditioning operation to be described below in the summertime and the wintertime. Thus, in the embodiment, results of detecting presence or non-presence by the human detection sensor 21B in the past 30 days are used to generate presence/non-presence patterns such that accuracy of presence/non-presence patterns are ensured and predictions of behaviors of the user based on the results of predicting whether the user will be present and recommendations of the air-conditioning operation can be made in an appropriate time. Note that the results of detecting presence or non-presence in the past 30 days are information obtained by accumulating results of detecting presence or non-presence every 10 minutes in 30 days. The embodiment exemplifies the case where the results of detection by the human detection sensor 21B in the past 30 days are used to generate presence/non-presence patterns; however, the present invention is limited to them. Changes may be made as appropriate according to the period from the time when the air conditioner 2 is set until the time when the air conditioner 2 is used frequently.

[0040] The day-of-week information is information on the days of week that are Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday and is obtained by calculation by the CPU 34. The national holiday information is information that identifies national holidays from among the days of week of Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday and is acquired from the outside via the second communication unit 32. Note that the national holiday information is acquired from the outside because there is the case where a national holiday changes every year. The prediction result memory 33C stores results of predicting presence

or non-presence in 24 hours that are results of predicting whether a human will be present in the air conditioning space every 10 minutes in 24 hours using the presence/non-presence patterns. The CPU 34 is able to recognize the results of predicting presence or non-presence in 24 hours with respect to each air conditioning space with reference to the prediction result memory 33C. The external memory 33D stores the external data that is acquired from the outside, such as the national holiday information and weather forecasts described above.

[0041] The CPU 34 includes a collector 34A, a transmitter 34B, a receiver 34C, a setting unit 34D, and a presence/non-presence predictor 34E.

[0042] The collector 34A acquires results of detecting whether a human is present in each air conditioning space at given periods, for example, in acquisition timing of every 10 minutes from the indoor unit 21. The air conditioning space is, for example an air conditioning space, such as a living room or a bed room. The collector 34A collects the acquired current results of detecting whether a human is present in the acquired air conditioning space by the human detection sensor 21B every 10 minutes. There are three types of variables for non-presence, presence, and unspecified. Among the results of detecting presence or non-presence, "non-presence" is a result of detection in the case where no human can be detected in the air-conditioning space. The result of detection of "non-presence" is a second detection value. Among the results of detecting presence or non-presence, "presence" is a result of detection in the case where a human is detected in the air-conditioning space. This result of detection of "presence" is a first detection value. Among the results of detecting presence or non-presence, "unspecified" corresponds to none one of presence and non-presence, in other words, is a third detection value not corresponding to any one of the first detection value and the second detection value, and is a result of detection that is not used to generate a presence/non-presence pattern. The collector 34A stores the results of detecting presence or non-presence in each air conditioning space that is acquired every 10 minutes in the history memory 33A.

[0043] When the results of detecting presence or non-presence in two days are stored in the history memory 33A, transmitter 34B transmits the results of detecting presence or non-presence in two days that are stored in the history memory 33A to the server device 5 via the communication network 8. Note that, the server device 5 generates five types of presence/non-presence patterns at maximum described above using the results of detecting presence or non-presence in the past 30 days that are sequentially received from the communication adapter 3. The receiver 34C receives the presence/non-presence pattern with respect to each air conditioning space from the server device 5 via the communication network 8 and stores the received presence/non-presence pattern in the presence/non-presence pattern memory 33B. The setting unit 34D applies the presence/non-presence patterns being stored to the presence/non-presence predictor 34E.

[0044] The presence/non-presence predictor 34E selects a presence/non-presence pattern that is used for prediction from among the presence/non-presence patterns that are applied by the setting unit 34D, using the current results of detection by the human detection sensor 21B, that is, results of detecting presence or non-presence that are the results of detection by the human detection sensor 21B from the time at which presence or non-presence is predicted to a time a certain time before, the current day-of-week information, and the current national holiday information. The presence/non-presence predictor 34E predicts whether a human will be present in the air conditioning space using the selected presence/non-presence pattern and obtains results of predicting presence or non-presence in 24 hours. The certain time is a time needed to obtain the number of sets of data that make it possible to ensure accuracy in selecting an optimum presence/non-presence pattern from among the presence/non-presence patterns in view of the last result of detecting presence or non-presence.

[0045] Selecting a presence/non-presence pattern that is used for prediction and a method of predicting whether the user will be present using the selected presence/non-presence pattern will be described in detail below. Note that the following description describes the case where predictions on whether the user will be present are made at 8:00 every day and predictions of presence or non-presence of the user in 24 hours from 8:00 of the day to 8:00 of the next day are made. In the embodiment, the predictions on the 24 hours are made separately with respect to two periods of 1) 8:00 of the day to 0:00 of the next day and 2) 0:00 of the next day to 8:00 of the next day and the predictions are used collectively as results of the prediction on the 24 hours.

<1) Prediction on whether user will be present from 8:00 of the day to 0:00 of the next day>

[0046] First of all, when the time to predict whether the user will be present, for example, 8:00 of the day comes, the presence/non-presence predictor 34E acquires results of detecting whether a human is present by the human detection sensor 21B from a time a certain time before the time of prediction, for example, from 21:00 of the day before the day of prediction until 8:00 of the day. Next, the presence/non-presence predictor 34E compares the presence/non-presence patterns with each other and determines whether there is a difference between the presence/non-presence patterns. Specifically, it is determined whether a difference between presence/non-presence patterns is equal to a given value or larger. More specifically, presence or non-presence of the user every 10 minutes from 0:00 to 8:00 in the presence/non-presence patterns are compared. When the number of portions ("time frames" below) between which

presence or non-presence differs is smaller than a given value, for example, 10, it is determined that the difference between the presence/non-presence patterns is within an allowable range (there is no difference between the patterns on presence and non-presence from 0:00 to 8:00). On the other hand, when the number of time frames on which presence or non-presence of the user every 10 minutes from 0:00 to 8:00 differs is 10 or larger, it is determined that the difference between the presence/non-presence patterns is out of the allowable range (there is a difference between the patterns of presence and non-presence from 0:00 to 8:00).

[0047] Based on the results of comparing the presence/non-presence patterns, the presence/non-presence predictor 34E selects a presence/non-presence pattern to be used for prediction. When the difference between the presence-non-presence patterns is smaller than a given value (when there is no difference between the patterns of presence and non-presence from 0:00 t0 8:00), a presence/non-presence pattern that is associated with the day or week of the day of prediction is selected. When the difference between the presence-non-presence patterns is equal to or larger than the given value (when there is a difference between the patterns of presence and non-presence from 0:00 t0 8:00), the results of detecting whether a human is present that are acquired from 0:00 to 8:00 and presence and non-presence from 0:00 t0 8:00 in each presence/non-presence pattern are compared to each other. A presence/non-presence pattern that is most approximate to the results of detection is selected. The presence/non-presence predictor 34E extracts presence and non-presence from 8:00 to 0:00 in the selected presence/non-presence pattern as results of predicting whether the user will be present from 8:00 of the day to 0:00 of the next day. Associating each presence/non-presence pattern and the day-of-week information are associated with each other and predicting whether the user is present according to the results of comparison between presence/non-presence patterns as described above makes it possible to predict whether the user will be present accurately while reducing the number of presence/non-presence patterns to a number smaller than the number of days of week.

[0048] It is originally desirable to generate a presence/non-presence pattern with respect to each day of week and select a presence/non-presence pattern to be used according to the day of week of the day on which it is actually predicted whether the user will be present. This is because generating a presence/non-presence pattern with respect to each day of week makes it possible to expect an increase in accuracy of prediction. Increasing the number of presence/non-presence patterns more however causes an increase in the amount of communication between the communication adapter 3 and the server device 5 and an increase in the capacity of memory needed for the communication adapter and the air conditioning system 1 is overloaded.

[0049] Thus, in the embodiment, presence/non-presence patterns are up to five types at maximum and the same pattern is applied to a day of week of which predicted presence/non-presence pattern is regarded as the same as described above. For example, Presence/non-presence pattern 1 is applied to Monday and Tuesday, Presence/non-presence pattern 2 is applied to Wednesday and Thursday, Presence/non-presence pattern 3 is applied to Thursday and Friday, Presence/non-presence pattern 4 is applied to Saturday, and Presence/non-presence pattern 5 is applied to Sunday. Generating a presence/non-presence pattern to meet a plurality of days of week however has a risk that accuracy of prediction lowers compared to the case where a presence/non-presence pattern is generated with respect to each day of week and the patterns are used to predict whether the user will be present.

[0050] In order to deal with such a situation, in the embodiment, the method of selecting a presence/non-presence pattern to be used to predict whether the user will be present according to the results of comparing presence/non-presence patterns. When the difference between the presence/non-presence patterns is smaller than the given value, it is not possible to determine which of the presence/non-presence patterns should be used using the acquired information on whether the user is present until the time of prediction (8:00) and thus, if a presence/non-presence pattern that meets the day of week of the day of prediction is selected, accuracy of prediction does not lower. When the difference between the presence/non-presence patterns is equal to or larger than the given value, it is possible to distinguish the presence/non-presence patterns and thus, by comparing the acquired information on whether the user is present and the results of prediction of each presence/non-presence patterns and selecting a presence/non-presence pattern that is the most approximate to the results of detection, accuracy of prediction is ensured.

<2) Prediction on whether User will be present from 0:00 of the next day to 8:00 of the next day>

[0051] First of all, the presence/non-presence predictor 34E reads the day of week of the next day of the day on which it is predicted whether the user will be present from the external memory 33D. Next, the presence/non-presence predictor 34E selects a presence/non-presence pattern corresponding to the read day of week from the presence/non-presence patterns. The presence/non-presence predictor 34E extracts results of predicting whether the user will be present from 0:00 of the next day to 8:00 of the next day from the selected presence/non-presence pattern.

[0052] At the stage of 8:00 of the day on which it is predicted whether the user will be present, different from the case where 1) it is predicted whether the user will be present from the day 8:00 to 0:00 of the next day, there is no result of detecting whether the user is present by

the human detection sensor 21B at and after 8:00 of the day. For this reason, in a prediction on whether the user will be present from 0:00 of the next day to 8:00 of the next day, a presence/non-presence pattern to be used for prediction is selected based on the day of week of the next day and it is predicted whether the user will be present from 0:00 of the next day to 8:00 of the next day using the selected presence/non-presence pattern.

[0053] Collectively using the result of 1) predicting whether the user will be present from 8:00 of the day to 0:00 of the next day and the result of 2) predicting whether the user will be present from 0:00 of the next day to 8:00 of the next day, the presence/non-presence predictor 34E predicts whether the user will be present in 24 hours from 8:00 of the day to 8:00 of the next day. The presence/non-presence predictor 34E outputs the results of prediction as the results of predicting presence or non-presence in 24 hours to the prediction result memory 33C. The prediction result memory 33C stores the results of predicting presence or non-presence in 24 hours. When the time frame on which predictions are made contains a national holiday, the presence/non-presence predictor 34E regards the time frame as the same as a holiday and obtains results of predicting presence or non-presence in the air conditioning space in 24 hours. The presence/non-presence predictor 34E excludes a result of detecting presence or non-presence indicating "unspecified" (third detection value) in the results of detecting presence or non-presence that are results of detection by the human detection sensor 21B to be used to predict whether the user will be present in the air conditioning space. In other words, the results of detecting presence or non-presence indicating "unspecified" are excluded are not used to generate or update the presence/non-presence patterns and therefore it is possible to increase accuracy of prediction using the generated or updated presence/non-presence patterns.

[0054] For example, at 8:00 and 20:00 every day serving as given times that are times at which presence or non-presence is detected, the presence/non-presence predictor 34E may predict whether the user will be present in the air conditioning space from the given time to a time 24 hours later. Specifically, the presence/non-presence predictor 34E obtains results of predicting presence or non-presence in 24 hours that are results of predicting whether the user will be present. The presence/non-presence predictor 34E increases accuracy of prediction by obtaining results of detecting presence or non-presence in 24 hours from each of the given times every half a day. Results of predicting presence or non-presence in 24 hours are, for example, results of predicting whether the user is present in the air conditioning space, for example, every 10 minutes. FIG. 7 is an illustration illustrating an example of the results of predicting presence or non-presence in 24 hours. The results of predicting presence or no-presence illustrated in FIG. 7 are results of predicting presence or non-presence every 10 minutes from the given time to a time 24 hours later. Data presenting the results of predicting presence or no-presence presents "1" in the case of presence and "0" in the case of non-presence.

Configuration of Server Device

[0055] FIG. 8 is a block diagram illustrating an example of a configuration of the server device 5. The server device 5 illustrated in FIG. 8 includes a communication unit 51, a storage unit 52, and a CPU 53. The communication unit 51 is a communication IF that makes a communication connection between the relay device 6 and the CPU 53. The storage unit 52, for example, includes a HDD (Hard Disk Drive) and a ROM or a RAM and stores various types of information, such as data and a program. The CPU 53 controls the entire server device 5.

[0056] The storage unit 52 in the server device 5 illustrated in FIG. 8 includes a history data memory 52A and a pattern storage unit 52B. The history data memory 52A stores operation history data, such as results of detecting presence or non-presence in the air conditioning space in two days, received from the communication adapter 3. The pattern storage unit 52B stores the presence/non-presence patterns that are generated by the server device 5 and updates the generated presence/non-presence patterns using the acquired data and stores the updated presence/non-presence patterns.

[0057] The CPU 53 in the server device 5 includes a receiver 53A, an acquisition unit 53B, a generator 53C, and a transmitter 53D.

[0058] The receiver 53A is connected to the communication adapters 3 for a plurality of the indoor units 21, receives results of detecting presence or non-presence in every air conditioning space in two days from the communication adapter 3 via the router 4, the communication network 8, and the relay device 6 and stores the received results of detecting presence or non-presence in two days. The receiver 53A receives the days-of-week information and the national holiday information from the communication adapter 3. Note that the day-of-week information may be calculated by the CPU 53 of the server device 5 and be obtained and the national holiday information may be acquired by the server device 5 from the outside directly. The acquisition unit 53B acquires the day-of-week information and the national holiday information that are received by the receiver 53A. The acquisition unit 53B acquires the day-of-week information and the national holiday information that are received by the receiver 53A.

[0059] FIG. 9 is an illustration illustrating an example of the data that is used to generate a presence/non-presence pattern. The data used to generate a presence/non-presence pattern includes the results of detecting presence or non-presence serving as sensor data, the day-of-week information serving as day-of-week data, and the national holiday information serving as national holiday data. The results of detecting presence or non-presence are, as described above, results of detecting wheth-

er a human is present in the air conditioning space by the human detection sensor 21B every 10 minutes. As described above, a result of detecting presence or non-presence indicating "unspecified" is not used to generate or update a presence/non-presence pattern.

[0060] During a given period of storage in the history data memory 52A, the generator 53C, for example, uses the results of detecting presence or non-presence in 30 days that are the results of detection in the past, the day-of-week information and the national holiday information and generates a presence/non-presence of the user in the air conditioning space of the indoor unit 21. The generator 53C stores the generated presence/non-presence pattern in the pattern storage unit 52B. When the time frame corresponding to the results of detecting presence or non-presence contains a national holiday, the generator 53C regards the time frame as a holiday. After storing the presence/non-presence pattern in the pattern storage unit 52B, the generator 53C updates the presence/non-presence patterns being stored in the pattern storage unit 52B using the results of detecting presence or non-presence in six days in the history data memory 52A that are not used for generation. The generator 53C then stores the updated presence/non-presence patterns in the pattern storage unit 52B.

[0061] When the air conditioner 2 is set in a living room, the generator 53C extracts results of detecting presence or non-presence on a weekday, for example, Monday (excluding national holidays) from the results of detecting presence or non-presence in the living room that are being stored in the history data memory 52A. Furthermore, the generator 53C extracts results of detecting presence or non-presence excluding "unspecified" from the extracted results of detecting presence or non-presence on Monday and, based on the extracted results of detecting presence or non-presence in the living room, generates a presence/non-presence pattern predicting whether a human will be present in the living room on Monday.

[0062] The generator 53C extracts results of detecting presence or non-presence on national holidays and Sunday from the results of detecting presence or non-presence in the living room that are being stored in the history data memory 52A. Furthermore, the generator 53C extracts results of detecting presence or non-presence excluding "unspecified" from the results of detecting presence or non-presence on national holidays and Sunday and, based on the extracted results of detecting presence or non-presence in the living room, generates a presence/non-presence pattern predicting whether a human will be present in the living room on Sunday.

[0063] In other words, the generator 53C generates a presence/non-presence pattern of each day of week in the air conditioning space in which the indoor unit 21 is set. Note that, for convenience of explanation, the case where a presence/non-presence pattern of each day of week is generated is exemplified and, for example, the days from Monday to Friday excluding national holidays may be regarded as weekdays and a presence/non-presence pattern of each air conditioning space of the weekdays may be generated and the national holidays, Saturday and Sunday may be regarded as holidays and a presence/non-presence pattern of each air conditioning space of the holidays may be generated. National holidays, Saturday and Sunday are exemplified as holidays; however, holidays are not limited to this, and, for example, Tuesday may be set as a holiday regardless of the holidays and the national holidays on the calendar and it is possible to make a change.

[0064] FIG. 10 is an illustration illustrating an example of the generated presence/non-presence patterns of the user. Pattern 1 that is a presence/non-presence pattern illustrated in FIG. 10 is a presence/non-presence pattern presenting presence and non-presence of the user in the air conditioning space on Monday and Tuesday. Note that, although not illustrated in the drawings, a presence/non-presence pattern of the user in the air conditioning space from Wednesday to Saturday excluding national holidays is also predicted. Pattern 2 is a presence/non-presence pattern presenting presence or non-presence of the user in the air conditioning space of Sunday and national holidays.

[0065] Based on the results of detecting presence or non-presence, the day-of-week information, and the national holiday information, the generator 53C generates or updates the presence/non-presence pattern with respect to each air conditioning space and each day of week and stores the generated or updated presence/non-presence patterns in the pattern storage unit 52B. The transmitter 53D transmits the presence/non-presence pattern with respect to each air conditioning space and each day of week that are being stored in the pattern storage unit 52B to the communication adapter 3 via the relay device 6, the communication network 8, and the router 4.

<About Generation of Presence/non-presence Patterns in Air Conditioning System>

[0066] Generation of a presence/non-presence patterns in the air conditioning system 1 of the embodiment will be described next. FIG. 11 is a flowchart illustrating an example of process operations performed by the CPU 53 of the server device 5 involved in the generating process of generating a presence/non-presence pattern. The generating process is a process of generating a presence/non-presence pattern first after the air conditioner 2 is set in an air conditioning space later. The receiver 53A in the CPU 53 of the server device 5 in FIG. 11 communicates with the communication adapter 3 regularly, for example, at 0:00 every day and determines whether results of detecting presence or non-presence in two days with respect to each air conditioning space are received from the communication adapter 3 (step S11). Note that the communication adapter 3 keeps storing in the history memory 33A until results of detecting presence or non-presence in two days are obtained.

When the results of detecting presence or non-presence in two days are obtained (Step 11: Yes), the receiver 53A stores the received results of detecting presence or non-presence in two days in the history data memory 52A of the storage unit 52 (step S12). The generator 53C in the CPU 53 determines whether results of detecting presence or non-presence in 30 days are stored in the history data memory 52A (step S13). When results of detecting presence or non-presence in 30 days are stored (step S13: Yes), the generator 53C generates a presence/non-presence pattern of each day of week with respect to each air conditioning space based on the stored results of detecting presence or non-presence, the day-of-week information, and the national holiday information (step S14). Note that, when acquiring results of detecting presence or non-presence in two days, the acquisition unit 53B in the CPU 53 collectively acquires the day-of-week information and the national holiday information on the days of detection of the results of detecting presence or non-presence in two days or associates the day-of-week information and the national holiday information that are acquired by the server device 5 with the acquired results of detecting presence or non-presence in two days. The case where the generator 53C generates a presence/non-presence pattern of each day of week is exemplified; however, two presence/non-presence patterns of holidays and weekdays may be generated, and a change may be made as appropriate.

[0067] The generator 53C stores the generated presence/non-presence pattern in the pattern storage unit 52B (step S15). The transmitter 53D in the CPU 53 transmits the presence/non-presence pattern stored in the pattern storage unit 52B to the communication adapter 3 (step S16) and ends the process operations in FIG. 11.

[0068] In the process at step S11, when results of detecting presence or non-presence in two days with respect to each air conditioning space are not received (step S11: No), the receiver 53A returns to the process at step S11. In the process at step S13, when results of detecting presence or non-presence in 30 days are not stored (step S13: No), the receiver 53A returns to the process at step S11.

[0069] When the results of detecting presence or non-presence in 30 days with respect to each air conditioning space from the communication adapter 3 are stored, the CPU 53 generates a presence/non-presence pattern of each day of week on which it is predicted whether the user is present in the air conditioning space based on the results of detecting presence or non-presence in 30 days, the day-of-week information, and the national holiday information. The CPU 53 then transmits the generated presence/non-presence pattern to the communication adapter 3. As a result, the server device 5 is able to provide the presence/non-presence pattern of each day of week that is used in the air conditioning space to the communication adapter 3.

[0070] FIG. 12 is a flowchart illustrating an example of process operations performed by the CPU 53 of the server device 5 involved in an updating process of updating presence/non-presence patterns. The updating process is a process of updating the content of presence/non-presence patterns stored in the pattern storage unit 52B. The receiver 53A in FIG. 12 communicates with the communication adapter 3 regularly, for example, at 0:00 every day and determines whether results of detecting presence or non-presence in two days with respect to each air conditioning space are received from the communication adapter 3 (step S21). Note that the communication adapter 3 keeps storing in the history memory 33A until results of detecting presence or non-presence in two days are obtained. When the results of detecting presence or non-presence in two days are obtained (Step 21: Yes), the receiver 53A stores the received results of detecting presence or non-presence in two days in the history data memory 52A of the storage unit 52 (step S22). The generator 53C determines whether results of detecting presence or non-presence in 6 days that are not used for generation are stored in the history data memory 52A (step S23).

[0071] When the results of detecting presence or non-presence in 6 days that are not used for generation are stored (step S23: Yes), the generator 53C updates the presence/non-presence patterns of the respective days of week with respect to each air conditioning space based on the stored results of detecting presence or non-presence, the day-of-week information, and the national holiday information (step S24). The generator 53C stores the updated presence/non-presence patterns of the respective days of week with respect to each air conditioning space in the pattern storage unit 52B (step S25). The transmitter 53D transmits the presence/non-presence patterns of the respective days of week with respect to each air conditioning space that are stored in the pattern storage unit 52B to the communication adapter 3 (step S26). The receiver 53A then returns to the process at step S21 in order to determine whether results of detecting presence/non-presence in two days with respect each air conditioning space are received.

[0072] In the process at step S21, when results of detecting presence or non-presence in two days are not received (step S21: No), the receiver 53A returns to the process at step S21. In the process at step S23, when results of detecting presence or non-presence in 6 days are not stored (step S23: No), the receiver 53A returns to the process at step S21.

[0073] Each time results of detecting presence or non-presence in 6 days are obtained from the communication adapter 3 after generation of the presence/non-presence patterns, the CPU 53 updates the presence/non-presence patterns of the respective days of week with respect to the conditioning space based on the results of detecting presence or non-presence in 6 days, the day-of-week information, and the national holiday information. The CPU 53 then transmits the updated presence/non-presence patterns to the communication adapter 3. As a result, the server device 5 is able to provide the communi-

cation adapter 3 with the latest presence/non-presence patterns of the respective days of week to be used for the air conditioning space.

[0074] FIG. 13 is a flowchart illustrating an example of process operations performed by the controller 21D of the indoor unit 21 involved in a power-saving process. The power-saving process is a process of, using results of detection by the human detection sensor 21B and results of prediction by the presence-non-presence predictor 34E, continuing the power-saving operation or switching from the air-conditioning operation to any one of the first power-saving operation and the second power-saving operation. The controller 21D of the indoor unit 21 in FIG. 13 determines whether it is in the air conditioning operation in the cooling mode, the dehumidifying mode, or the heating mode (step S31). When it is in the air-conditioning operation (step S31: Yes), the controller 21D determines whether the human detection sensor 21B detects whether no human is present (step S32). Note that the controller 21D loads results of detection by the human detection sensor 21B, for example, every 10 milliseconds and substantially keeps loading results of detection by the human detection sensor 21B.

[0075] When the human detection sensor 21B detects that no human is present (step S32: Yes), based on the results of predicting presence or non-presence that is acquired from the presence/non-presence predictor 34E of the communication adapter 3, the controller 21D extracts results of predicting whether a human will be present in the first given time from the current time, that is, a time at which the human detection sensor 21B detects that no human is present (step S34). Note that the results of predicting whether a human will be present in the first given time from the current time is, for example, the results of predicting whether a human will be present in the air-conditioning space from the current time to a time 60 minutes ahead.

[0076] Based on the extracted results of predicting whether a human will be present, the controller 21D determines whether the results of predicting whether a human will be present in the first given time all indicate non-presence (step S35). When the results of predicting whether a human will be present in the first given time all indicate non-presence (step S35: Yes), the controller 21D executes the second power-saving operation (step S36), and ends the processing operations illustrated in FIG. 13. The controller 21D determines that the user will not be present in the air conditioning space and executes the second power-saving operation, thereby making it possible to reduce the power consumption compared to, needless to say, the case where the air conditioner 2 is performing the air conditioning operation and the case where the air conditioner 2 is performing the first power-saving operation. When the human detection sensor 21B detects that a human is present while the air conditioning operation is stopped because of the second power-saving operation in the process at step S36, the second power-saving operation may be stopped and the air conditioning operation performed before the second power-saving operation may be restarted.

[0077] When the results of predicting whether a human will be present in the first given time all indicate non-presence (step S35: No), the controller 21D determines whether the results of predicting whether a human will be present in the first given time all indicate presence according to the extracted results of predicting whether a human will be present (step S37). When the results of predicting whether a human will be present in the first given time all indicate presence (step S37: Yes), the controller 21D determines whether the human detection sensor 21B keeps detecting that no human is present in the second given time from the time at which the human detection sensor 21B detects that no human is present in the process at step S32 (step S38).

[0078] When it is kept detected that no human is present in the second given time from the time at which the human detection sensor 21B detects that no human is present (step S38: Yes), the controller 21D returns to the process at step S36 in order to execute the second power-saving operation. In the case where it is determined that no human is present in the air conditioning space according to the results of detection by the human detection sensor 21B even when the results of predicting whether a human is present in the first given time all indicate presence, the controller 21D is able to reduce the power consumption of the air conditioner 2 as appropriate by executing the second power-saving operation. When it is not kept detected that no human is present in the second given time from the time at which the human detection sensor 21B detects that no human is present (step S38: No), the controller 21D ends the processing operations illustrated in FIG. 13 while keeping the air-conditioning operation that is performed currently. In this case, by determining that no human is present in the air conditioning space and continues the air conditioning operation, the controller 21D is able to ensure comfortableness to a human in the air conditioning space.

[0079] When the results of predicting whether a human will be present in the first given time all indicate non-presence (step S37: No), the controller 21D recognizes that presence or non-presence are mixed in the results of predicting whether a human will be present in the first given time or there is no result of prediction (step S39). The controller 21D then executes the first power-saving operation (step S40). When presence and non-presence are mixed in the results of predicting whether a human will be present in the first given time or there is no results of prediction, there is a possibility that the user is present in the air conditioning space and thus the controller 21D executes the first power-saving operation in which, while the power-saving effect is lower than that in the second power-saving operation, the air conditioning operation is not stopped, thereby ensuring comfortableness to the user while reducing the power consumption of the air conditioner 2. When the human detection sensor 21B detects that a human is present while the first power sav-

ing operation is being executed in the process at step S40, the fist power-saving operation may be stopped and the air conditioning operation performed before the first power-saving operation may be restarted.

[0080] After executing the first power-saving operation, the controller 21D determines whether the human detection sensor 21B keeps detecting that no human is present during the third given time from the time when the human detection sensor 21B detects that no human is present in the process at step S32 (step S41).

[0081] When it is kept detected that no human is present during the third given time from the time at which the human detection sensor 21B detects that no human is present in the process at step S32 (Step S41: Yes), the controller 21D returns to step S36 in order to execute the second power-saving operation. Even in the case where there is a possibility that a human is present as a result of the process at step S39, when the controller 21D determines that no human is present in the air conditioning space according to the results of detection by the human detection sensor 21B, the controller 21D executes the second power-saving operation, thereby making possible to reduce the power consumption of the air conditioner 2.

[0082] When the human detection sensor 21B does not keep detecting that no human is present during the third given time from the time at which the human detection sensor 21B detects that no human is present (step S41: No), the controller 21D returns to the process at step S40 and keeps the first power-saving operation. When the controller 21D does not keep detecting that no human is present during the third given time, the controller 21D determines that there is a possibility that a human is present in the air conditioning space and keeps the first power-saving operation, thereby making it possible to ensure comfortableness to the user while reducing the power consumption of the air conditioner 2.

[0083] When it is not in the air-conditioning operation (step S31: No), or when the human detection sensor 21B does not detect that no human is present (step S32: No), the controller 21D ends the process operation illustrated in FIG. 13.

<Effect of Embodiment 1>

[0084] Using results of detection by the human detection sensor 21B and results of prediction by the presence/non-presence predictor 34E, the controller 21D makes a switch from the air conditioning operation to the power-saving operation of which power consumption is smaller than that of the air conditioning operation. As a result, for example, when it is detected that no human is present during execution of the air conditioning operation and it is predicted that no human will be present from results of predicting presence or non-presence, it is determined that the user is not present in the air conditioning space and switching from the air-conditioning operation to the power-saving operation makes it possible to prioritize a power-saving effect of reducing the power consumption of the air conditioner 2. In other words, the air conditioner 2 is able to realize comfortableness by performing the air conditioning operation when the user is present in the air conditioning space and is able to increase energy-saving by performing the power-saving operation when the user is not in the air-conditioning space.

[0085] When the controller 21D detects that a human is present during execution of the power-saving operation, the controller 21D restarts the air-conditioning operation. As a result, even during execution of the power-saving operation, when the human detection sensor 21B detects that a human is present, the air conditioning operation is restarted and thus it is possible to ensure comfortableness to the user in the air conditioning space.

[0086] The controller 21D refers to the results of prediction by the presence/non-presence predictor 34E from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when the results of prediction all indicate that a human is present, the controller 21D keeps the air-conditioning operation. As a result, even when it is temporarily detected that no human is present during execution of the air conditioning operation, when the results of predicting presence or non-presence indicate that a human will be present, it is determined that the user is present in the air conditioning space and the air conditioning operation is kept, which makes it possible to ensure comfortableness to the user in the air conditioning space.

[0087] The controller 21D refers to the results of prediction by the presence/non-presence predictor 34E on the first given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction on the first given time indicate that a human will be present according the referred results of prediction, the controller 21D keeps the air conditioning operation. As a result, even when it is temporarily detected that no human is present during execution of the air conditioning operation, it is determined that the user will be present in the air conditioning space in the first given time and the air conditioning operation is kept, which makes it possible to ensure comfortableness to the user in the air conditioning space.

[0088] The controller 21D refers to the results of prediction by the presence/non-presence predictor 34E on the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction on the first given time all indicate that no human is present according the referred results of prediction, the controller 21D makes a switch from the air conditioning operation to the power-saving operation. For example, the controller 21D refers to the results of prediction by the presence/non-presence predictor 34E

on the first given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction all indicate that no human will be present according the referred results of prediction, the controller 21D makes a switch from the air conditioning operation to the power-saving operation. As a result, when it is detected that no human is present during execution of the air-conditioning operation and no human is present from the results of predicting presence or non-presence, a switch from the air conditioning operation to the power-saving operation is made and therefore it is possible to prioritize the power-saving effect.

[0089] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E on the first given time, for example, 60 minutes from the time when the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction all indicate that no human is present according to the referred results of prediction, the power-saving operation execution unit 21D1 makes a switch from the air-conditioning operation to the second power-saving operation. As a result, because it is determined that no user will be present in the air conditioning space in the first given time from detection of non-presence of a human during execution of the air conditioning operation and a switch from the air conditioning operation to the second power-saving operation is made, it is possible to reduce the power consumption compared to, needless to say, the case where the air conditioner 2 is performing the air conditioning operation and the case where the air conditioner is performing the first power-saving operation.

[0090] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E on the first given time, for example, 60 minutes during execution of the air conditioning operation. The power-saving operation execution unit 21D1 keeps the air-conditioning operation when the results of prediction all indicate that a human is present according to the referred results of prediction. As a result, even when it is temporarily detected that no human is present during execution of the air-conditioning operation, it is determined that the user will be present in the air-conditioning space in the first given time and the air-conditioning operation is kept, which makes it possible to ensure comfortableness to the user in the air conditioning space.

[0091] When the human detection sensor 21B keeps detecting that no human is present during the second given time, for example, 60 minutes from the time at which the human detection sensor 21B detects that no human is present when keeping the air conditioning operation, the power-saving operation execution unit 21D1 makes a switch from the air conditioning operation to the second power-saving operation. As a result, even in the case where the results of predicting presence or non-presence in the first given time all indicate that a human will be present and the air conditioning operation is kept, because it is determined that the user is not present in the air conditioning space and a change from the air conditioning operation to the second power-saving operation is made, it is possible to reduce the power consumption of the air conditioner 2 as appropriate.

[0092] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E on the first given time, for example, 60 minutes during execution of the air conditioning operation. When presence of the user and non-presence of the user are mixed in the referred results of prediction according to the results of prediction, the power-saving operation execution unit 21D1 makes a switch from the air-conditioning operation to the first-power saving operation. As a result, when presence of a human and non-presence of a human are mixed as the results of predicting presence or non-presence in the first given time from detection of non-presence of a human during execution of the air conditioning operation, it is determined that there is a possibility that the user is present in the air conditioning space. Then, a switch from the air conditioning operation to the first power-saving operation is made, which thus makes it possible to reduce the power consumption while ensuring comfortableness to the user in the air conditioning space.

[0093] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 34E on the first given time, for example, 60 minutes during execution of the air conditioning operation. When there is no result of prediction to be referred to, the power-saving operation execution unit 21D1 makes a switch from the air-conditioning operation to the first-power saving operation. As a result, when there is no result of predicting presence or non-presence in the first given time from detection of non-presence of a human during execution of the air conditioning operation, it is determined that there is a possibility that the user is present in the air conditioning space. Then, a switch from the air conditioning operation to the first power-saving operation is made, which thus makes it possible to reduce the power consumption while ensuring comfortableness to the user in the air conditioning space.

[0094] In the case where it is kept detected that no human is present for the third given time, for example, 180 minutes from the time at which the human detection sensor 21B detects that no human is present when the power-saving operation execution unit 21D1 is executing the first power-saving operation because presence and non-presence are mixed in the results of prediction in the first given time from the time at which the human detection sensor 21B detects that no human is present or there is no result of prediction, the power-saving operation execution unit 21D1 makes a switch from the first power-saving operation to the second power-saving operation.

As a result, in the case where it is determined that no human is present in the air conditioning space according to the results of detection by the human detection sensor 21B even when the first power-saving operation is being executed, that is, there is a possibility that a human is present, it is possible to reduce the power consumption of the air conditioner 2 by executing the second power-saving operation.

<Modification of Embodiment 1>

[0095] Note that, as for the communication adapter 3 of Embodiment 1, the case where a presence/non-presence pattern to be used for prediction is selected from a plurality of presence/non-presence patterns using results of detecting presence or non-presence, day-of-week information, and national holiday information and it is predicted whether the user is present in the air conditioning space using the selected presence/non-presence pattern is exemplified; however, the server device 5 may predict whether the user will be present in the air conditioning space. In this case, the server device 5 selects a presence/non-presence pattern to be used for prediction from a plurality of presence/non-presence patterns using results of detecting presence or non-presence from the given time at which at which it is predicted whether the user will be present in the air conditioning space to a time a given time before, day-of-week information, and national holiday information. The server device 5 then transmits results of predicting presence or non-presence to the air conditioner 2 via the communication adapter 3. As a result, because the server device 5 is able to generate a presence/non-presence pattern and execute prediction of presence or non-presence, it is able to reduce the processing load on the side of the communication adapter 3.

[0096] The presence/non-presence predictor 34E selects a presence/non-presence pattern to be used for prediction from a plurality of presence/non-presence patterns using results of detecting presence or non-presence from a given time to a time a given time before, day-of-week information, and national holiday information. The case where the presence/non-presence predictor 34E predicts presence or non-presence in the air conditioning space in 24 hours using the selected presence/non-presence pattern has been exemplified. The presence/non-presence predictor 34E however may select a presence/non-presence pattern to be used for prediction using results of detecting presence or non-presence from a given time to a time a given time before and day-of-week information even without national holiday information.

[0097] As for the air conditioning system 1, the case where the air conditioner 2, the communication adapter 3, and the server device 5 are used for process sharing such that generating a presence/non-presence pattern is to the server device 5, predicting presence or non-presence is to the communication adapter 3, and making an instruction to start the air-conditioning operation is to the indoor unit 21 of the air conditioner 2 has been exemplified; however, the communication adapter 3 may be caused to execute predicting presence or non-presence and making an instruction to start the air conditioning operation, that is, the communication adapter 3 may execute all the processes in FIG. 11 and FIG. 12 and changes may be made as appropriate.

[0098] The air conditioner 2 may be caused to execute processes of generating a presence-non-presence pattern, predicting presence or non-presence, and making an instruction to start the air conditioning operation and an embodiment thereof will be described as Embodiment 2 below. Note that the same components as those of Embodiment 1 are denoted with the same reference numerals as those of Embodiment 1 and thus description of redundant configurations and operations will be omitted.

<Embodiment 2>

[0099] FIG. 14 is a block diagram illustrating an example of a configuration of an air conditioner 2A of Embodiment 2. An indoor unit 210 in the air conditioner 2A illustrated in FIG. 14 includes, in addition to the main unit 21A, the human detecting sensor 21B, the light receiving unit 21C, and the controller 21D, an acquisition unit 21E1, a presence/non-presence pattern 21F, a generator 21G, and a presence/non-presence predictor 21H. The acquisition unit 21E1 acquires day-of-week information. The presence/non-presence pattern 21F is a pattern obtained by generating a presence/non-presence pattern indicating whether a user is present in an air conditioning space with respect to each day of week.

[0100] The generator 21G generates the presence/non-presence pattern 21F using results of detecting presence or non-presence by the human detection sensor 21B, day-of-week information, and national holiday information. When a time frame corresponding to the results of detecting presence or non-presence by the human detection sensor 21B contains a national holiday, the generator 21G regards the time frame as the same as a holiday. Note that a result of detecting presence or non-presence indicating "unspecified" among the results of detecting presence or non-presence is not used for the presence/non-presence pattern 21F. The presence/non-presence predictor 21H selects a presence/non-presence pattern to be used for prediction using the results of detecting presence or non-presence from a given time that is a time at which it is predicted whether the user will be present to a time a given time before from a plurality of presence/non-presence patterns. Furthermore, using the selected presence/non-presence pattern, the presence/non-presence predictor 21H predicts whether the user will be present in the air conditioning space. The controller 21D makes a switch from an air-conditioning operation to a power-saving operation of which power consumption is smaller than the

air-conditioning operation using the results of detection by the human detection sensor 21B and results of prediction by the presence/non-presence predictor 21H to be described below. The power-saving operation execution unit 21D1 in the controller 21D makes a switch from the air conditioning operation to any one of a first power-saving operation to a second power-saving operation based on the length of a time during which the user is not present, which is the time obtained from the results of prediction by the presence/non-presence predictor 21H.

[0101] The generator 21G generates the presence/non-presence pattern 21F using results of detecting presence or non-presence by the human detection sensor 21B in a first given period, for example, 30 days. The generator 21G stores the results of detecting presence or non-presence by the human detection sensor 21B in a storage unit not illustrated in the drawings not via the communication adapter 3 and, using the stored results of detecting presence or non-presence, executes the generating process illustrated in FIG. 11 in order to generate or update the presence/non-presence pattern 21F.

[0102] At a given time, for example, 8:00 or 20:00 every day, the presence/non-presence predictor 21H predicts whether the user will be present in the air conditioning space in a second given period from the given time, for example, to a time 24 hours later using the selected presence/non-presence pattern. The presence/non-presence predictor 21H predicts whether the user will be present in the air conditioning space every third given time, for example, every 10 minutes. When the time frame on which predictions are made contains a national holiday, the presence/non-presence predictor 21H regards the time frame as the same as a holiday and predicts presence or non-presence in the air conditioning space in 24 hours. The presence/non-presence predictor 21H excludes a result of detecting presence or non-presence indicating "unspecified" from the results of detecting presence or non-presence by the human detection sensor 21B that are used to predict whether the user will be present in the air conditioning space.

[0103] Based on the results of detection by the human detection sensor 21B and the results of prediction by the presence/non-presence predictor 21H, the power-saving operation execution unit 21D1 keeps the air conditioning operation or switches from the air conditioning operation to any one of the first power-saving operation and the second power-saving operation.

[0104] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 21H on a first given time, for example, 60 minutes from a time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation. When the results of prediction all indicate that no human is present according to the referred results of prediction, the power-saving operation execution unit 21D1 determines that the user will not be present in the air conditioning space in the first given time and makes a switch from the air conditioning operation to the second power-saving operation.

[0105] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 21H on the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when the results of prediction all indicate that a human is present, the power-saving operation execution unit 21D1 determines that the user will be present in the air conditioning space during the first given time and keeps the air conditioning operation without making a switch to the power-saving operation.

[0106] When the power-saving operation execution unit 21D1 keeps the air conditioning operation because the results of prediction performed after the human detection sensor 21B detects that no human is present all indicate presence and when the human detection sensor 21B detects that no human is present, in the case where it is kept detected that no human is present during a second given time from the time at which the non-presence is detected, the power-saving operation execution unit 21D1 determines that the user is not present in the air conditioning space. The power-saving operation execution unit 21D1 then makes a switch from the air conditioning operation to the second power saving operation.

[0107] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 21H on the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, when presence of a human and non-presence of a human are mixed in the results of prediction, determines that there is a possibility that the user will be present in the air-conditioning space in the first given time and makes a switch from the air conditioning operation to the first power-saving operation.

[0108] The power-saving operation execution unit 21D1 refers to the results of prediction by the presence/non-presence predictor 21H on the first given time from the time at which the human detection sensor 21B detects that no human is present during execution of the air conditioning operation and, for example, even when the presence/non-presence predictor 34E has no result of prediction because presence/non-presence patterns to be described below are being generated, determines that there is a possibility that the user is present in the air-conditioning space and makes a switch from the air conditioning operation to the first power saving operation.

[0109] When the first power-saving operation is being executed because presence of a human and non-presence of a human are mixed in the results of prediction performed after the human detection sensor 21B detects that no human is present or the presence/non-presence

predictor 21H has no result of prediction and when the human detection sensor detects that no human is present, in the case where it is kept detected that no human is present for a third given time, for example, 180 minutes from the time at which the no-presence is detected, the power-saving operation execution unit 21D1 determines that the user is not present in the air conditioning space. The power-saving operation execution unit 21D1 then makes a switch from the first power saving operation to the second power saving operation.

<Effect of Embodiment 2>

[0110] Using results of detection by the human detection sensor 21B and results of prediction by the presence/non-presence predictor 21H, the air conditioner 2A of Embodiment 2 makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that of the air conditioning operation. As a result, for example, when it is detected that no human is present during execution of the air conditioning operation and results of predicting presence or non-presence in the first given time from the time at which it is detected that no human is present contains non-presence of a human, it is determined that no human will be present in the air conditioning space in the first given time or the first given time has a time frame in which no human is present in the air conditioning space. A switch from the air-conditioning operation to the appropriate power-saving operation is made according to the time on which on which non-presence of a human is predicted and thus it is possible to reduce the power consumption while ensuring comfortableness to the user.

<Modification of Embodiments>

[0111] The given time, the first given time, the second given time, and the third given time of Embodiments 1 and 2 are changeable as appropriate.

[0112] Each component of each unit illustrated in the drawings need not necessarily be configured physically as illustrated in the drawings. In other words, specific modes of distribution and integration of units are not limited to those illustrated in the drawings and all or part of the units can be configured by functional or physical distribution or integration in any unit according to various types of load and usage.

[0113] Furthermore, all or given part of various types of processing functions implemented by each device may be executed on a CPU (Central Processing Unit) (or a microcomputer, such as or a MPU (Micro Processing Unit) or a MCU (Micro Controller Unit)). Needless to say, all or any part of the various types of processing functions may be executed on a program that is analyzed and executed by the CPU (or a microcomputer, such as a MPU or a MCU) or on hardware according to a wired logic.

Reference Signs List

[0114]

1	AIR CONDITIONING SYSTEM
2, 2A	AIR CONDITIONER
3	COMMUNICATION ADAPTER
5	SERVER DEVICE
21, 210	INDOOR UNIT
21B	HUMAN DETECTION SENSOR
21D	CONTROLLER
21D1	POWER-SAVING OPERATION EXECUTION UNIT
21F	PRESENCE/NON-PRESENCE PATTERN
21G	GENERATOR
21H	PRESENCE/NON-PRESENCE PREDICTOR
34E	PRESENCE/NON-PRESENCE PREDICTOR

Claims

1. An air conditioner comprising:

a human detection sensor that detects whether a human is present in an air conditioning space;
a presence/non-presence predictor that predicts whether a human will be present in the air conditioning space;
a controller that, using results of detection by the human detection sensor and results of prediction by the presence/non-presence predictor, makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that of the air conditioning operation.

2. The air conditioner according to claim 1, wherein the controller restarts the air-conditioning operation when the human detection sensor detects that a human is present during execution of the power-saving operation.

3. The air conditioner according to claim 2, wherein the controller refers to results of prediction by the presence/non-presence predictor from a time at which the human detection sensor detects that no human is present during execution of the air-conditioning operation and, when the results of the prediction indicate that a human is present, keeps the air conditioning operation.

4. The air conditioner according to claim 2, wherein the controller refers to results of prediction by the presence/non-presence predictor on a given time from a time at which the human detection sensor detects that no human is present during execution of the air

conditioning operation and, when the results of detection indicate that the human is present, keeps the air conditioning operation.

5. The air conditioner according to claim 2, wherein the controller refers to results of prediction by the presence/non-presence predictor from a time at which the human detection sensor detects that no human is present during execution of the air-conditioning operation and, when the results of the prediction indicate that no human is present, makes a switch from the air conditioning operation to the power-saving operation.

6. The air conditioner according to claim 2, wherein the controller refers to results of prediction by the presence/non-presence predictor on a given time from a time at which the human detection sensor detects that no human is present during execution of the air conditioning operation and, when the results of detection indicate that no human is present, makes a switch from the air conditioning operation to the power-saving operation.

7. The air conditioner according to any one of claims 1 to 6, wherein the power-saving operation includes

a first power-saving operation of changing a set temperature in the air conditioning operation before the switch to the power-saving operation and of which power consumption is smaller than that of the air-conditioning operation before the switch to the power-saving operation; and
a second power-saving operation of stopping the air-conditioning operation.

8. The air conditioner according to claim 7, wherein the controller includes a power-waving operation execution unit that makes a switch from the air conditioning operation to any one of the first power-saving operation and the second power-saving operation based on a length of time in which no human is present that is obtained from the results of prediction by the presence/non-presence predictor.

9. The air conditioner according to claim 8, wherein the power-waving operation execution unit refers to results of prediction by the presence/non-presence predictor on a first given time from a time at which the human detection sensor detects that no human is present during execution of the air conditioning operation and, when the results of detection indicate that no human is present, makes a switch from the air conditioning operation to the second power-saving operation.

10. The air conditioner according to claim 9, wherein the power-waving operation execution unit refers to results of prediction by the presence/non-presence predictor on the first given time during execution of the air conditioning operation and, when the results of detection indicate that a human is present, keeps the air conditioning operation.

11. The air conditioner according to claim 10, wherein, when the human detection sensor keeps detecting that no human is present during a second given time from the time at which the human detection sensor detects that no human is present when the air conditioning operation is kept, the power-saving operation execution unit makes a switch from the air conditioning operation to the second power-saving operation.

12. The air conditioner according to claim 9, wherein, the power-saving operation execution unit refers to results of prediction by the presence/non-presence predictor on the first given time during execution of the air conditioning operation and, when presence and non-presence of a human are mixed in the results of prediction, makes a switch from the air-conditioning operation to the first power-saving operation.

13. The air conditioner according to claim 12, wherein, when it is kept detected that no human is preset during a third given time from the time at which the human detection sensor detects that no human is present during execution of the first power-saving operation, the power-saving operation execution unit makes a switch from the first power-saving operation to the second power-saving operation.

14. An air conditioning system comprising an air conditioner including a human detection sensor that detects whether a human is present in an air conditioning space; a server device that generates a plurality of presence/non-presence patterns that are generated using results of detection by the human detection sensor in the past and that represents a tendency of presence and non-presence of a user in the air conditioning space; and a communication adapter that makes communication between the air conditioner and the server device,
wherein the air conditioning system comprises:

a presence/non-presence predictor that selects a presence/non-presence pattern from the presence/non-presence patterns using results of detection by the human detection sensor and that predicts whether a human will be present in the air conditioning space using the selected presence/non-presence pattern; and
a controller that makes a switch from an air conditioning operation to a power-saving operation of which power consumption is smaller than that

of the air conditioning operation using results of detection by the human detection sensor and results of prediction by the presence/non-presence predictor.

15. The air conditioning system according to claim 14, wherein

the presence/non-presence predictor is in the server device, and
the controller is in the air conditioner.

16. The air conditioning system according to claim 14, wherein

the presence/non-presence predictor is in the communication adapter, and
the controller is in the air conditioner.

FIG.1

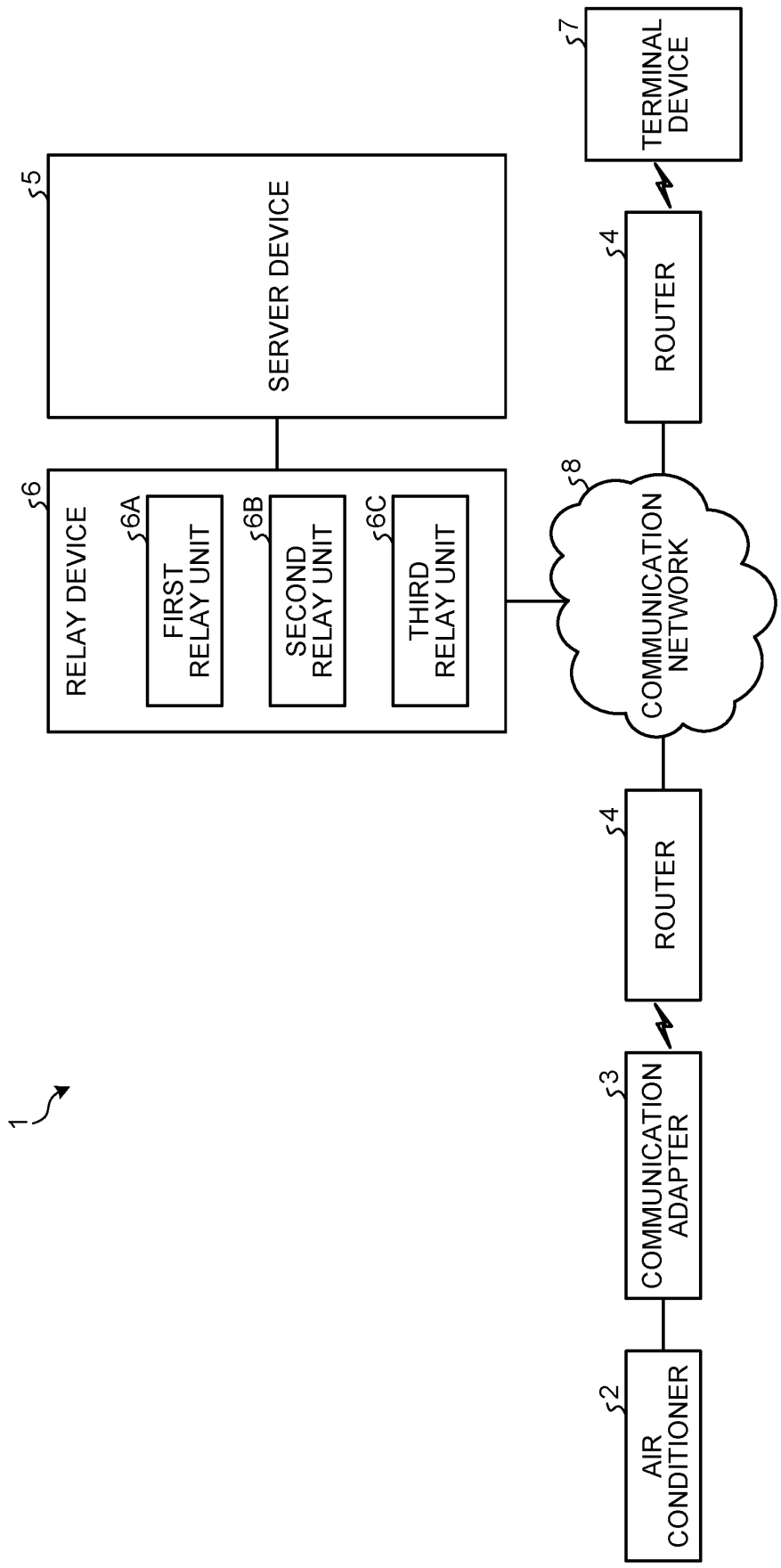

1
AIR CONDITIONER
2
COMMUNICATION ADAPTER
3
ROUTER
4
COMMUNICATION NETWORK
8
ROUTER
4
TERMINAL DEVICE
7
SERVER DEVICE
5
RELAY DEVICE
6
FIRST RELAY UNIT
6A
SECOND RELAY UNIT
6B
THIRD RELAY UNIT
6C

FIG.2

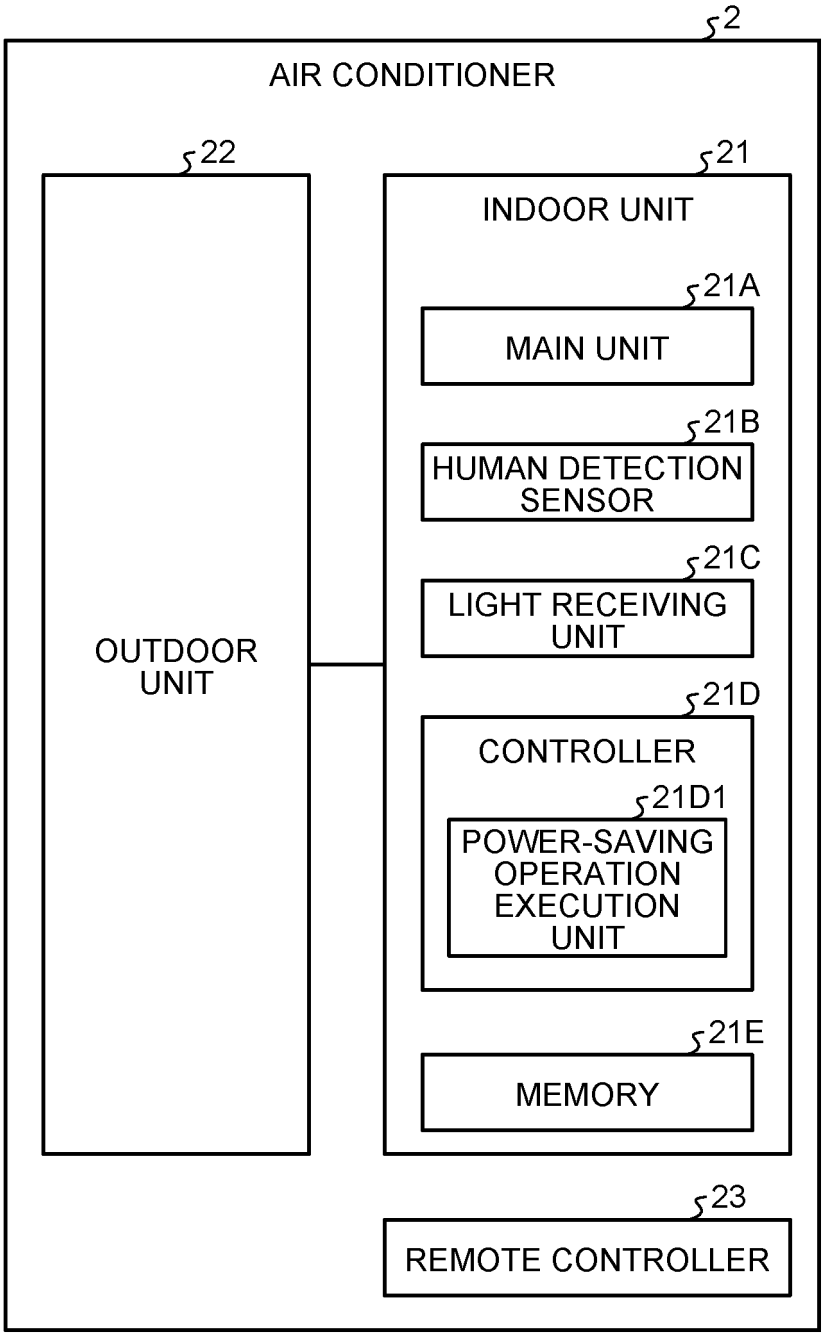

2
AIR CONDITIONER
22
OUTDOOR UNIT
21
INDOOR UNIT
21A
MAIN UNIT
21B
HUMAN DETECTION SENSOR
21C
LIGHT RECEIVING UNIT
21D
CONTROLLER
21D1
POWER-SAVING OPERATION EXECUTION UNIT
21E
MEMORY
23
REMOTE CONTROLLER

FIG.3

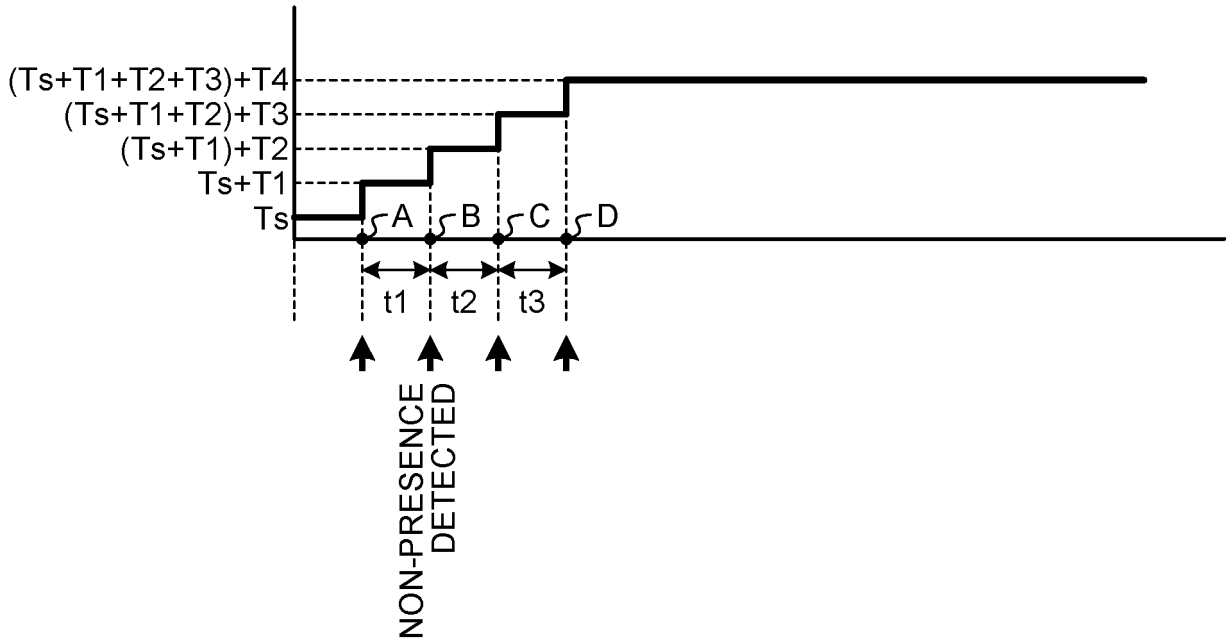

(Ts+T1+T2+T3)+T4
(Ts+T1+T2)+T3
(Ts+T1)+T2
Ts+T1
Ts
A
B
C
D
t1
t2
t3
NON-PRESENCE DETECTED

FIG.4

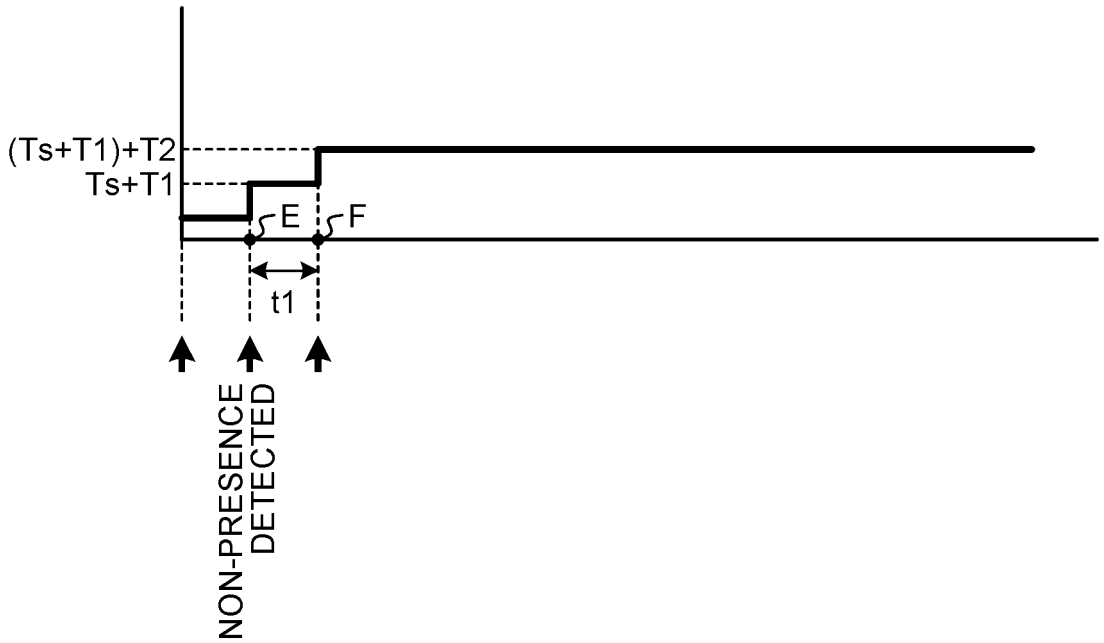

(Ts+T1)+T2
Ts+T1
E
F
t1
NON-PRESENCE DETECTED

FIG.5

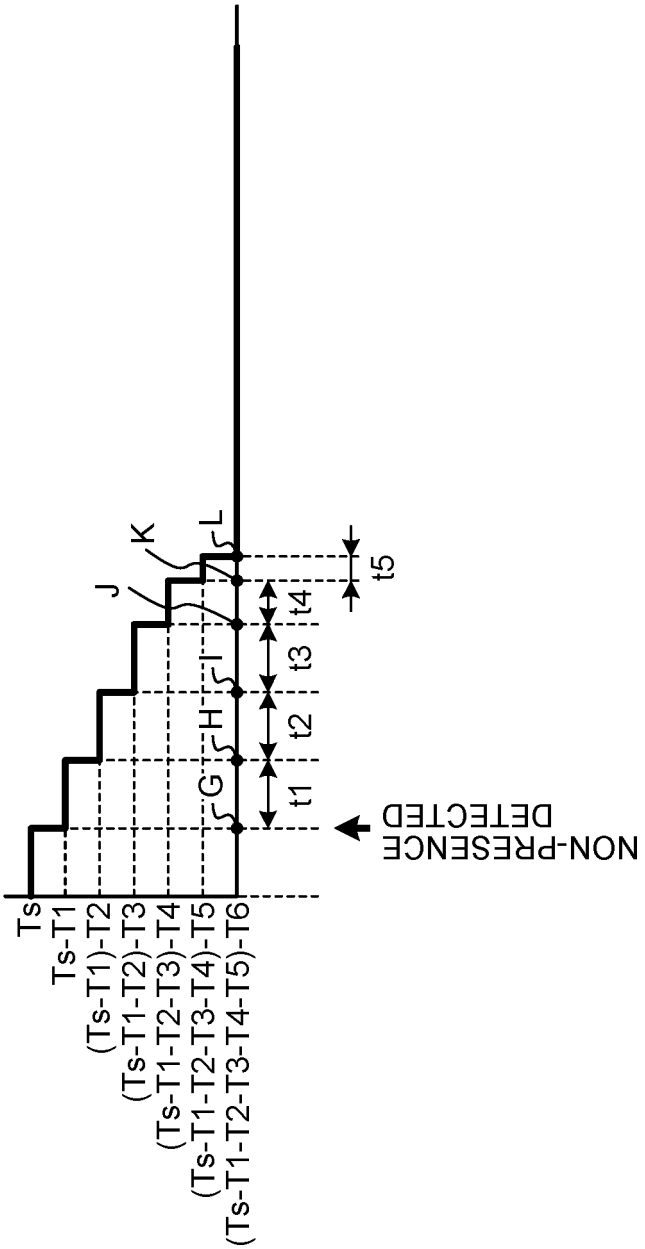

Ts
Ts-T1
(Ts-T1)-T2
(Ts-T1-T2)-T3
(Ts-T1-T2-T3)-T4
(Ts-T1-T2-T3-T4)-T5
(Ts-T1-T2-T3-T4-T5)-T6
G
H
I
J
K
L
t1
t2
t3
t4
t5
NON-PRESENCE DETECTED

FIG.6

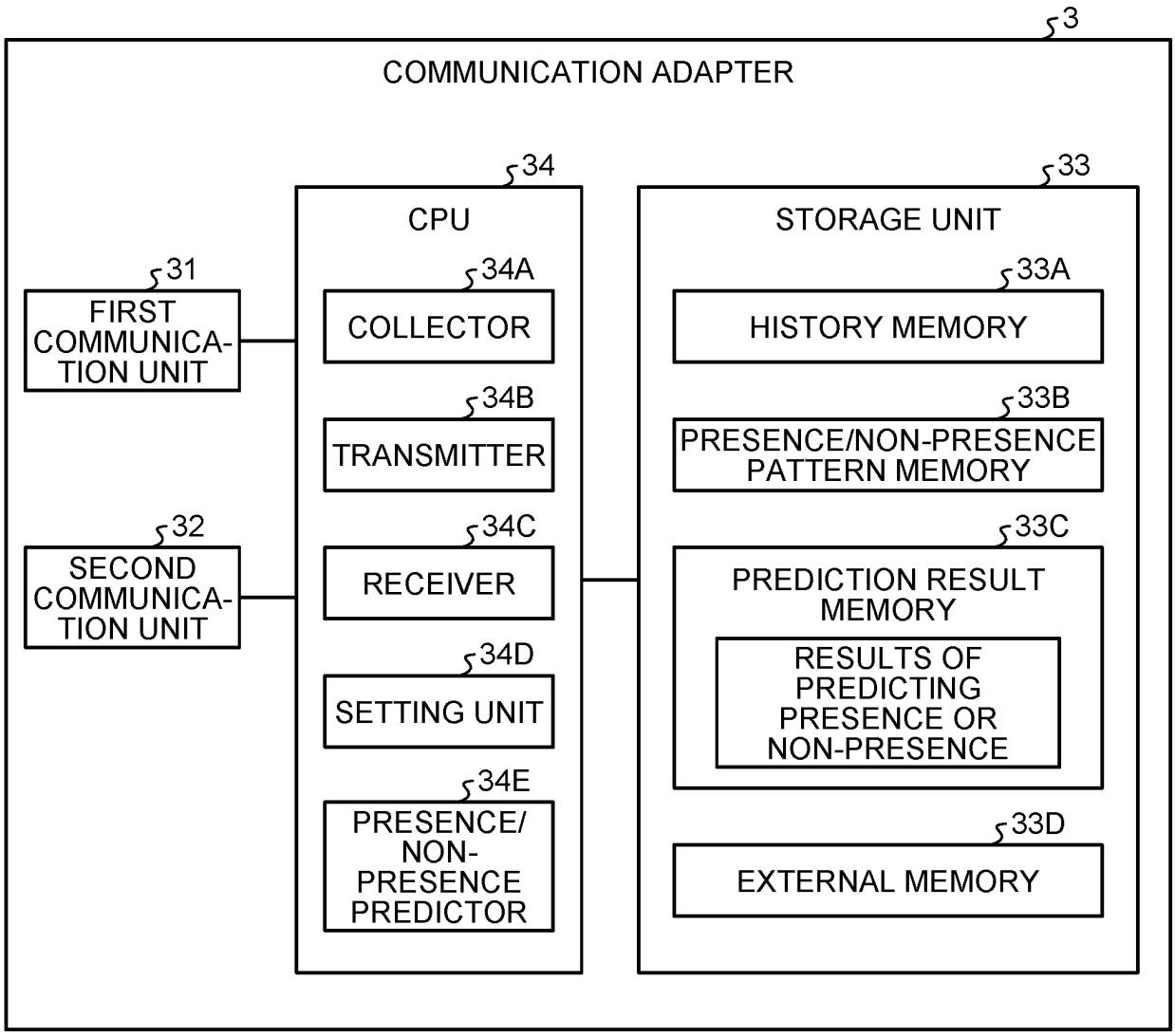

3
COMMUNICATION ADAPTER
34
CPU
34A
COLLECTOR
34B
TRANSMITTER
34C
RECEIVER
34D
SETTING UNIT
34E
PRESENCE/ NON-PRESENCE PREDICTOR
33
STORAGE UNIT
33A
HISTORY MEMORY
33B
PRESENCE/NON-PRESENCE PATTERN MEMORY
33C
PREDICTION RESULT MEMORY
RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE
33D
EXTERNAL MEMORY
31
FIRST COMMUNICA-TION UNIT
32
SECOND COMMUNICA-TION UNIT

FIG.7

···	23:10	23:20	23:30	···	7:10	7:20	7:30	···
···	1	0	0	···	0	0	1	···

PRESENT NOT PRESENT PRESENT

FIG.8

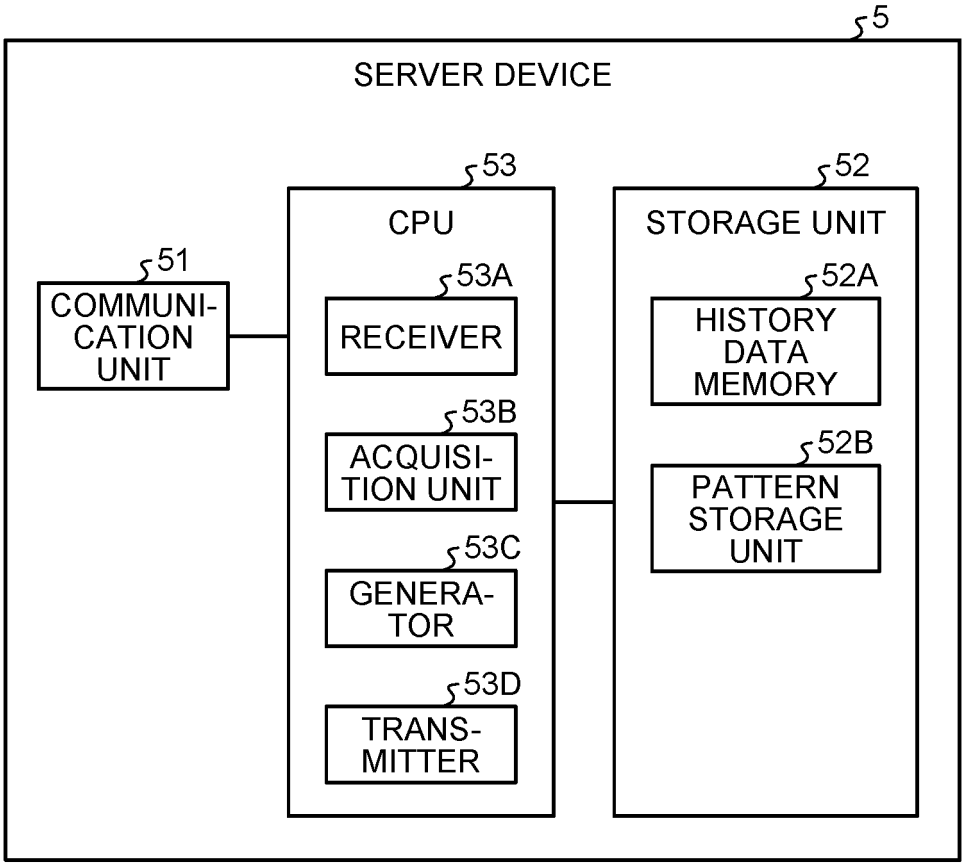


FIG.9

CLASSIFICATION	VARIABLE NAME	ACQUISITION OPPORTUNITY	VARIABLE
SENSOR DATA	RESULT OF DETECTING PRESENCE OR NON-PRESENCE	SENSOR DATA OF INDOOR UNIT	NON-PRESENCE/PRESENCE/ UNSPECIFIED
DAY-OF-WEEK DATA	DAY-OF-WEEK INFORMATION	CALCULATED BY COMMUNICATION ADAPTER FROM DATE	MON/TUE/WED/THU/ FRI/SAT/SUN
NATIONAL HOLIDAY DATA	NATIONAL HOLIDAY INFORMATION	ACQUIRED BY COMMUNICATION ADAPTER FROM OUTSIDE	TODAY IS NATIONAL HOLIDAY/ TODAY IS NOT NATIONAL HOLIDAY
			TOMORROW IS NATIONAL HOLIDAY/ TOMORROW IS NOT NATIONAL HOLIDAY

FIG.10

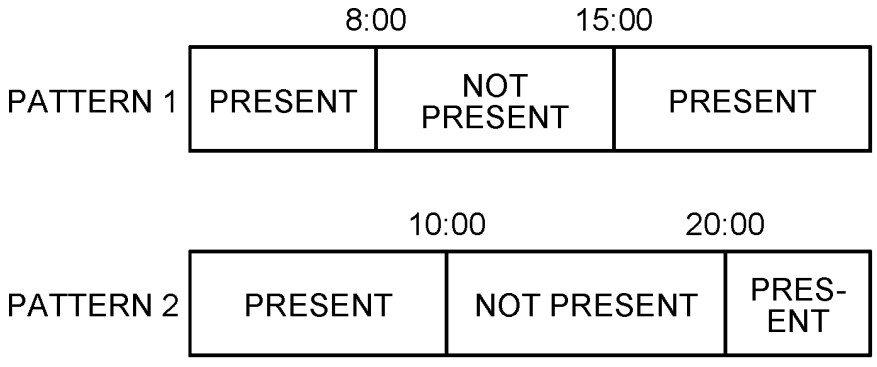


FIG.11

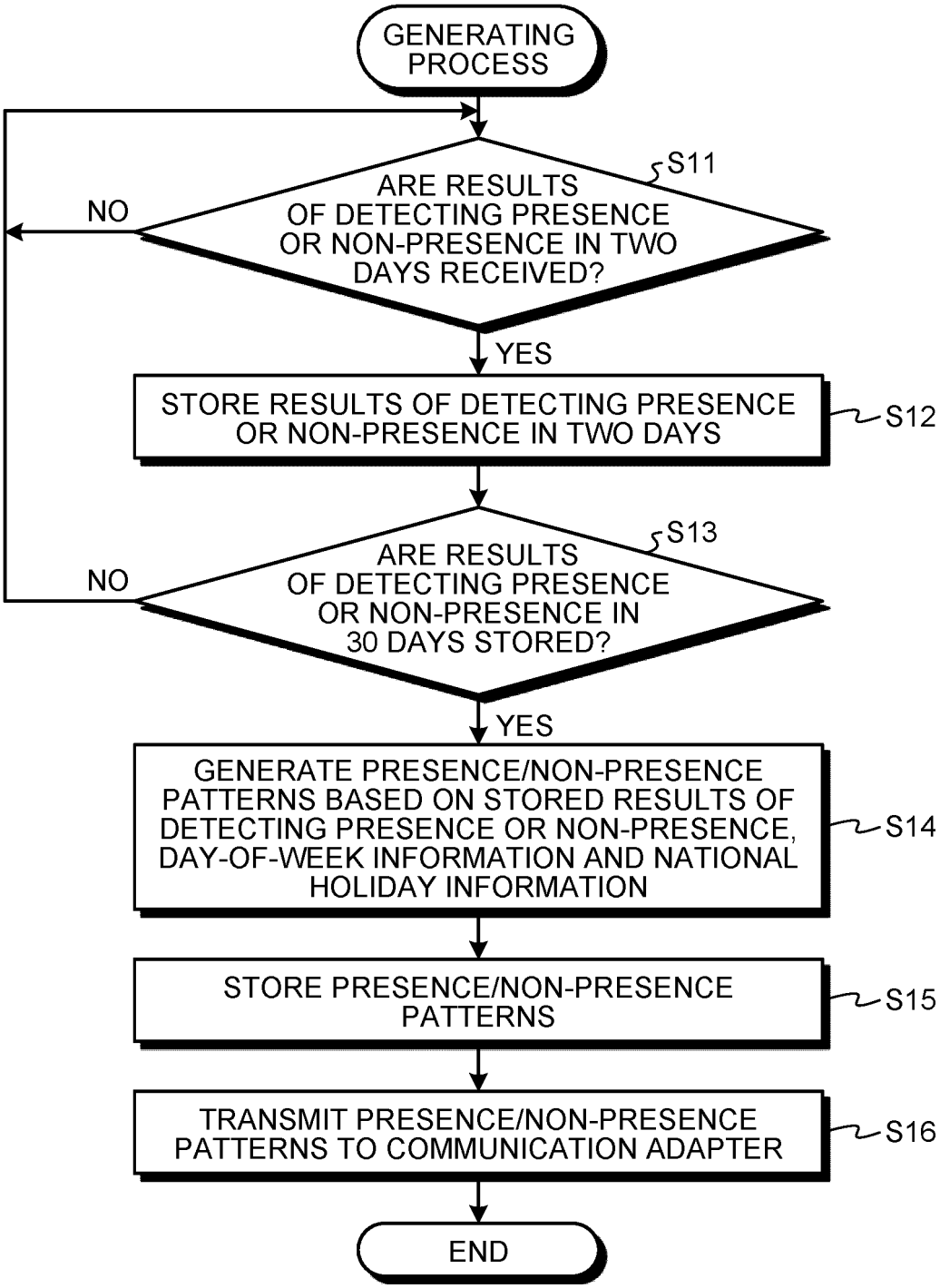

GENERATING PROCESS
S11
ARE RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN TWO DAYS RECEIVED?
NO
YES
STORE RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN TWO DAYS
S12
S13
ARE RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN 30 DAYS STORED?
NO
YES
GENERATE PRESENCE/NON-PRESENCE PATTERNS BASED ON STORED RESULTS OF DETECTING PRESENCE OR NON-PRESENCE, DAY-OF-WEEK INFORMATION AND NATIONAL HOLIDAY INFORMATION
S14
STORE PRESENCE/NON-PRESENCE PATTERNS
S15
TRANSMIT PRESENCE/NON-PRESENCE PATTERNS TO COMMUNICATION ADAPTER
S16
END

FIG.12

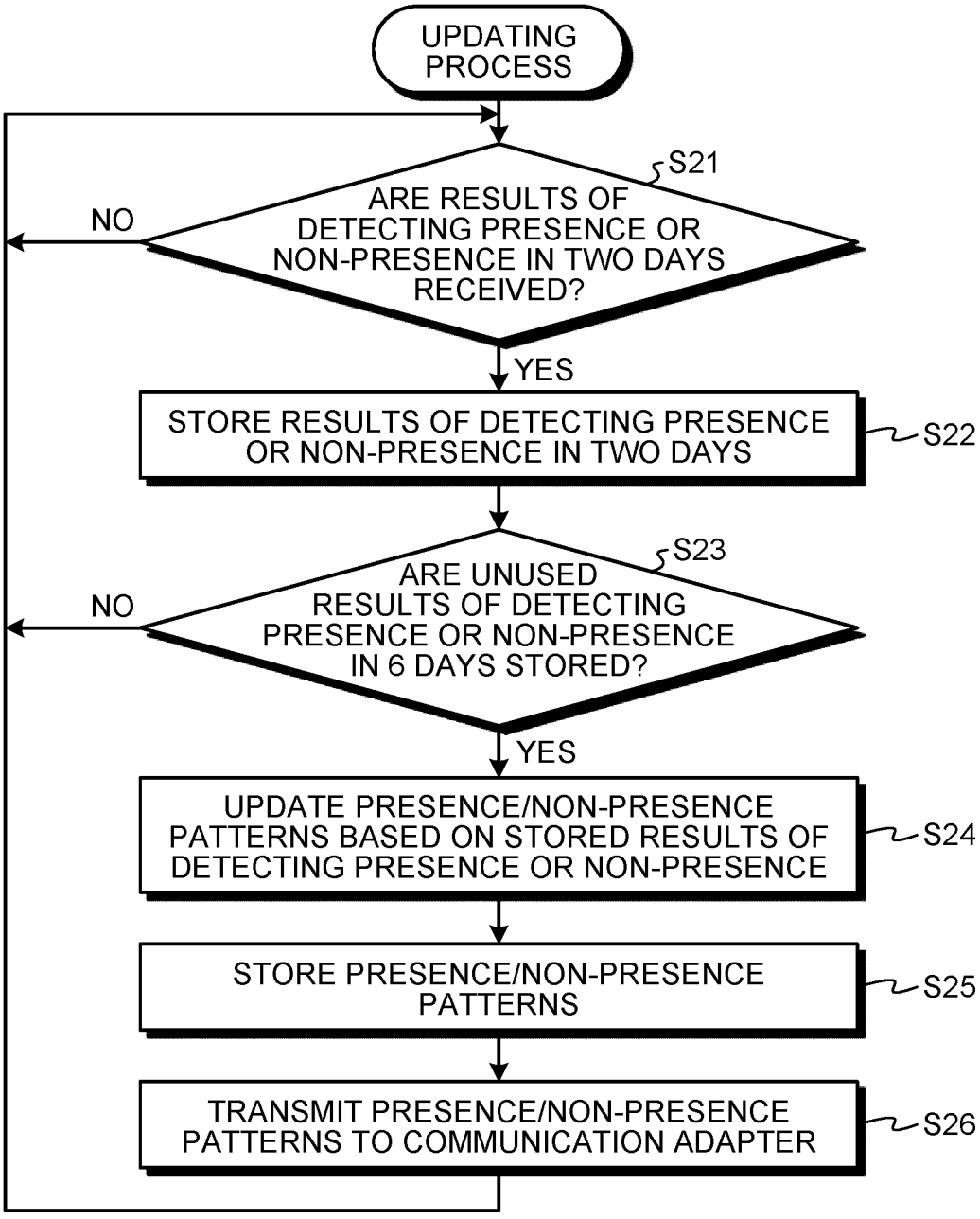

UPDATING PROCESS
S21
ARE RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN TWO DAYS RECEIVED?
NO
YES
STORE RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN TWO DAYS
S22
S23
ARE UNUSED RESULTS OF DETECTING PRESENCE OR NON-PRESENCE IN 6 DAYS STORED?
NO
YES
UPDATE PRESENCE/NON-PRESENCE PATTERNS BASED ON STORED RESULTS OF DETECTING PRESENCE OR NON-PRESENCE
S24
STORE PRESENCE/NON-PRESENCE PATTERNS
S25
TRANSMIT PRESENCE/NON-PRESENCE PATTERNS TO COMMUNICATION ADAPTER
S26

FIG.13

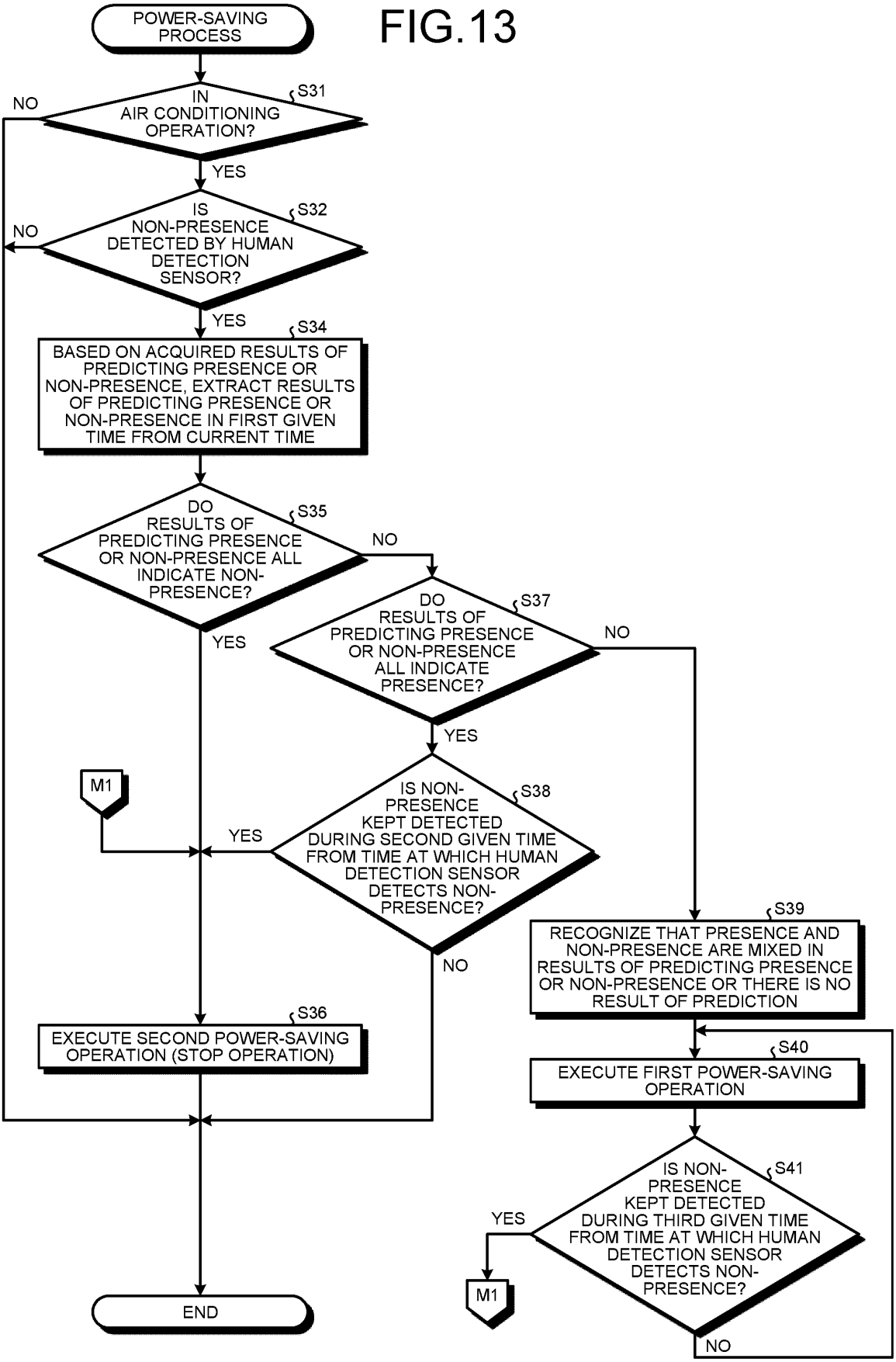
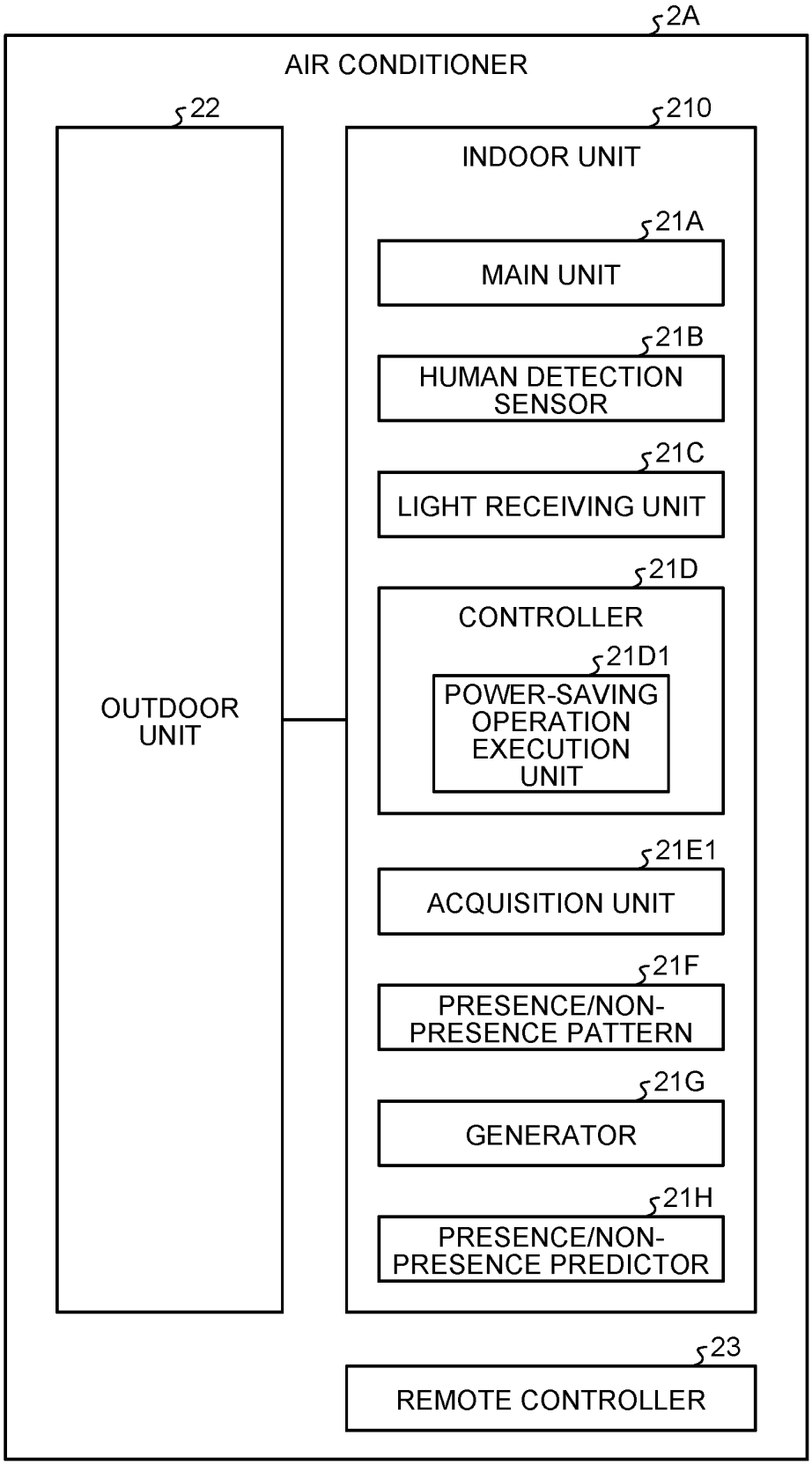

POWER-SAVING PROCESS
S31
IN AIR CONDITIONING OPERATION?
NO
YES
S32
IS NON-PRESENCE DETECTED BY HUMAN DETECTION SENSOR?
NO
YES
S34
BASED ON ACQUIRED RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE, EXTRACT RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE IN FIRST GIVEN TIME FROM CURRENT TIME
S35
DO RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE ALL INDICATE NON-PRESENCE?
NO
YES
S37
DO RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE ALL INDICATE PRESENCE?
NO
YES
M1
S38
IS NON-PRESENCE KEPT DETECTED DURING SECOND GIVEN TIME FROM TIME AT WHICH HUMAN DETECTION SENSOR DETECTS NON-PRESENCE?
YES
NO
S36
EXECUTE SECOND POWER-SAVING OPERATION (STOP OPERATION)
S39
RECOGNIZE THAT PRESENCE AND NON-PRESENCE ARE MIXED IN RESULTS OF PREDICTING PRESENCE OR NON-PRESENCE OR THERE IS NO RESULT OF PREDICTION
S40
EXECUTE FIRST POWER-SAVING OPERATION
S41
IS NON-PRESENCE KEPT DETECTED DURING THIRD GIVEN TIME FROM TIME AT WHICH HUMAN DETECTION SENSOR DETECTS NON-PRESENCE?
YES
M1
NO
END

FIG.14


2A
AIR CONDITIONER
22
OUTDOOR UNIT
210
INDOOR UNIT
21A
MAIN UNIT
21B
HUMAN DETECTION SENSOR
21C
LIGHT RECEIVING UNIT
21D
CONTROLLER
21D1
POWER-SAVING OPERATION EXECUTION UNIT
21E1
ACQUISITION UNIT
21F
PRESENCE/NON-PRESENCE PATTERN
21G
GENERATOR
21H
PRESENCE/NON-PRESENCE PREDICTOR
23
REMOTE CONTROLLER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/042175

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/46(2018.01)i; ***F24F 11/58***(2018.01)i; ***F24F 11/65***(2018.01)i; *F24F 120/10*(2018.01)n
FI: F24F11/46; F24F11/65; F24F11/58; F24F120:10

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)

F24F11/46; F24F11/58; F24F11/65; F24F120/10

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 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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.
X	JP 11-132530 A (MATSUSHITA ELECTRIC IND CO LTD) 21 May 1999 (1999-05-21) paragraphs [0047]-[0070], fig. 3-6	1
Y		2-11, 13-16
A		12
X	JP 7-158927 A (TOSHIBA CORP) 20 June 1995 (1995-06-20) paragraphs [0019]-[0058], fig. 1-7	1-2
Y		2-11, 13
Y	JP 8-261539 A (MITSUBISHI ELECTRIC CORP) 11 October 1996 (1996-10-11) paragraph [0020]	11
Y	JP 2021-63611 A (FUJITSU GENERAL LTD) 22 April 2021 (2021-04-22) paragraphs [0012]-[0067], fig. 1-6	14-16

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"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	Date of mailing of the international search report
11 January 2023	**24 January 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/042175

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	11-132530	A	21 May 1999	(Family: none)	
JP	7-158927	A	20 June 1995	(Family: none)	
JP	8-261539	A	11 October 1996	(Family: none)	
JP	2021-63611	A	22 April 2021	(Family: none)	

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Patent documents cited in the description

- JP 2016017663 A **[0003]**