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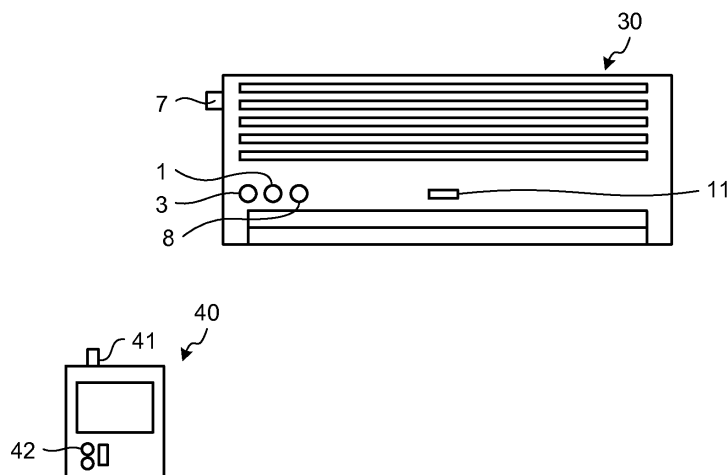
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INDOOR UNIT OF AIR CONDITIONER

(57) An indoor unit (30) of an air conditioner, includes: a first detection unit (2) that detects a human present in a space where the indoor unit of an air conditioner is provided, using audio data detected by a sound collecting unit (3); a second detection unit (21) that detects a human present in the space using imaging data from an imaging unit (11) that captures an image of the space; a signal reception unit (7) that receives an operation signal from a remote control unit (40) of the indoor unit; and a control unit (20) that controls an operation of the indoor unit on a basis of detection information from the first detection unit, detection information from the sec-

ond detection unit, and an operation signal from the signal reception unit, and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from an audio output unit (1), when any of the detection information from the first detection unit, the detection information from the second detection unit, and an operation signal from the signal reception unit is not input before a first time elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space after the air conditioner starts operating.

FIG.1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an indoor unit of an air conditioner.

2. Description of the Related Art

[0002] Air conditioners in recent years have been configured, when operating parameters thereof are set by a wireless or wired controller for an indoor air conditioner, to perform automatic air-conditioning on the basis of control signals from the controller, information from a room temperature detection sensor provided in an indoor unit of the air conditioner, information from a motion sensor that detects the presence or absence of a human present in an indoor air-conditioned space, and the like. Furthermore, in view of energy saving, some of air conditioners in recent years have been equipped with an automatic power-off function for automatically turning off the power of the air conditioner when no human is present in the air-conditioned space.

[0003] For example, Japanese Patent Application Laid-open No. 2008-72213 discloses a method of switching the mode of an air conditioner to a power saving mode when a motion sensor detects the absence of a human, and automatically turning off its power when the presence of a human is not detected for a predetermined period of time.

[0004] However, conventional techniques represented by Japanese Patent Application Laid-open No. 2008-72213 have a possibility of determining that no human is present in the room when a human is present outside the human detection range of the motion sensor, an imaging camera, or the like, and this results in automatic shifting to the power saving mode or in automatic turning-off of the power, thereby degrading user convenience.

[0005] The present invention has been achieved in view of the above problem, and an object of the present invention is to provide an indoor unit of an air conditioner that is capable of controlling an operation of the air conditioner without degrading user convenience.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0007] According to an aspect of the present invention, an indoor unit of an air conditioner, includes: a first detection unit that detects a human present in a space where the indoor unit of an air conditioner is provided, using audio data detected by a sound collecting unit; a second detection unit that detects a human present in

the space using imaging data from an imaging unit that captures an image of the space; a signal reception unit that receives an operation signal from a remote control unit of the indoor unit; and a control unit that controls an operation of the indoor unit on a basis of detection information from the first detection unit, detection information from the second detection unit, and an operation signal from the signal reception unit, and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from an audio output unit, when any of the detection information from the first detection unit, the detection information from the second detection unit, and an operation signal from the signal reception unit is not input before a first time elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space after the air conditioner starts operating.

[0008] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a schematic diagram showing an indoor unit and a remote controller of an air conditioner according to an embodiment of the present invention; FIG. 2 is a block diagram of functional elements incorporated in the indoor unit shown in FIG. 1; and FIG. 3 is a flowchart for explaining an operation of the indoor unit of the air conditioner according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Exemplary embodiments of an indoor unit of an air conditioner according to the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the embodiments.

Embodiment.

[0011] FIG. 1 is a schematic diagram showing an indoor unit 30 and a remote controller 40 of an air conditioner according to an embodiment of the present invention. FIG. 2 is a block diagram of functional elements incorporated in the indoor unit 30 shown in FIG. 1. FIG. 3 is a flowchart for explaining an operation of the indoor unit 30 of the air conditioner according to the present embodiment of the present invention.

[0012] The remote controller 40 includes an operation unit 42 that remotely sets an operating mode, a set tem-

perature, and the like of the air conditioner, and a communication unit 41 that communicates information with the indoor unit 30 via a wireless system or a wired system.

[0013] The indoor unit 30 includes, as main constituent elements, a control unit 20, a human detection unit 21, an audio output unit 1 as an audio output unit such as a speaker, an audio input unit 3 as a sound collecting unit such as a microphone, an audio processing unit 2, a heat exchanger 4, a blower fan 6, and a signal reception unit 7 that receives an operation signal from the remote controller 40 and relays the operation signal to an air-conditioning control unit 5. The human detection unit 21 includes a motion sensor 8, an imaging unit 11, and an image processing unit 10. The control unit 20 includes the air-conditioning control unit 5 and a timer unit 9. Other than these functional elements, for example, a room temperature detection sensor that detects the room temperature and a motor for driving the blower fan 6 are provided in the indoor unit 30.

[0014] The imaging unit 11 is, for example, a CCD (Charge Coupled Device) camera that captures an image of the inside of the room, and is arranged in the lower part in the middle of the front panel of the indoor unit 30 in the horizontal direction. The imaging unit 11 is provided such that the lens thereof has an optical axis oriented downward at a predetermined angle; therefore, the imaging unit 11 can properly capture an image of the inside of the room in which the indoor unit 30 is provided. The imaging unit 11 captures an image of the inside of the air-conditioned room, and imaging data 11a is output to the image processing unit 10. The image processing unit 10 determines whether a human is present in the room on the basis of the imaging data 11a from the imaging unit 11. When a human in the room is detected, the image processing unit 10 outputs detection information 10a indicating that a human is present in the room to the air-conditioning control unit 5.

[0015] The motion sensor 8 can be a combination of an infrared sensor and an ultrasound sensor, for example, or can be an infrared sensor or an ultrasound sensor. When a human in the room is detected by the motion sensor 8, detection information 8a indicating that a human is present in the room is output to the air-conditioning control unit 5.

[0016] The audio processing unit 2 has an audio recognition function and a notification function. With the audio recognition function, based on audio data 3a from the audio input unit 3, the ratio between the volume level of the sound (such as a speaking voice) and ambient noise (SN ratio) is calculated, and whether a human is present in the room in which the indoor unit 30 is provided is determined according to this SN ratio. With this determination, for example, when a human is present in the room, detection information 2a is output to the air-conditioning control unit 5, and when no human is present in the room, the output of the detection information 2a is stopped.

[0017] The notification function is a function for notifying the user that the air conditioner is to be shifted to a

power saving mode or a power-off mode (hereinafter, "power saving mode or the like") when an audio reproduction command 5a from the air-conditioning control unit 5 is received. With the notification function, it becomes possible that audio guidance information 2b is recorded in the audio processing unit 2 in advance and the audio guidance information 2b recorded in the audio processing unit 2 is read out and output to the audio output unit 1 upon reception of the audio reproduction command 5a from the air-conditioning control unit 5. The audio guidance information 2b is audio guidance that provides a notification indicating shifting of the air conditioner to the power saving mode or the like, such as "air conditioning will stop soon".

[0018] At least one of the detection information 8a from the motion sensor 8 and the detection information 10a from the image processing unit 10, an operation signal 7a from the signal reception unit 7, and the detection information 2a from the audio processing unit 2 are input to the air-conditioning control unit 5. Based on such pieces of information, the air-conditioning control unit 5 collectively controls the heat exchanger 4, the blower fan 6, and the like.

[0019] To explain more specifically, for example, when the remote controller 40 is operated to start an operation of the air conditioner when the air conditioner is in a non-operation state, the air-conditioning control unit 5 collectively controls the heat exchanger 4, the blower fan 6, and the like for air conditioning such that the room temperature detected by a room temperature detection sensor (not shown) provided in the indoor unit 30 approaches a predetermined temperature set by the remote controller 40.

[0020] After the air conditioner starts operating, when any of at least one of the detection information 8a and the detection information 10a is no longer received and also the detection information 2a is no longer received, the air-conditioning control unit 5 determines that no human is present in the room and outputs absence information 5b indicating that no human is present in the room to the timer unit 9. The timer unit 9 having received this absence information 5b starts time counting at a point in time when the absence information 5b is received and outputs the counted time as count information 9a to the air-conditioning control unit 5.

[0021] In this case, in the air-conditioning control unit 5, two times are set. The first time is a notification time T1 indicating a time from a point in time when the human detection unit 21 and the audio processing unit 2 no longer detect any human to a point in time when the audio reproduction command 5a is output. The second time is a mode transition time T2, which is longer than the notification time T1 and indicates a time from a point in time when the human detection unit 21 and the audio processing unit 2 no longer detect any human to a point in time when the air conditioner is shifted to the power saving mode or the like.

[0022] The air-conditioning control unit 5 having re-

ceived the count information 9a from the timer unit 9 compares the notification time T1 and a count time T3 (time counted by the timer unit 9) counted from a point in time when the count information 9a is received. When the remote controller 40 is operated, when the human detection unit 21 detects a human, or when the audio processing unit 2 detects a human before the count time T3 exceeds the notification time T1, the air-conditioning control unit 5 resets the time counting of the timer unit 9. That is, when the air-conditioning control unit 5 receives any of the operation signal 7a, the detection information 2a, the detection information 8a, and the detection information 10a, the time counting is reset.

[0023] When the remote controller 40 has not been operated and neither the human detection unit 21 nor the audio processing unit 2 has detected any human before the count time T3 exceeds the notification time T1, the air-conditioning control unit 5 outputs the audio reproduction command 5a at a point in time when the count time T3 has exceeded the notification time T1. That is, when the air-conditioning control unit 5 has not received any of the operation signal 7a, the detection information 2a, the detection information 8a, and the detection information 10a before the count time T3 exceeds the notification time T1, the audio reproduction command 5a is output. Accordingly, audio guidance is reproduced from the audio output unit 1; therefore, the user can be notified of the fact that shifting of the air conditioner to the power saving mode or the like is imminent.

[0024] Furthermore, the air-conditioning control unit 5 subsequently compares the count time T3 and the mode transition time T2. When the remote controller 40 is operated or any of the audio input unit 3 and the human detection unit 21 detects a human before the count time T3 exceeds the mode transition time T2, the air-conditioning control unit 5 resets the time counting of the timer unit 9. That is, when the air-conditioning control unit 5 receives any of the operation signal 7a, the detection information 2a, the detection information 8a, and the detection information 10a, the time counting is reset.

[0025] When the remote controller 40 has not been operated and neither the audio input unit 3 nor the human detection unit 21 has detected any human before the count time T3 exceeds the mode transition time T2, the air-conditioning control unit 5 controls the heat exchanger 4, a compressor of an outdoor unit (not shown), and the like such that the air conditioner is shifted to the power saving mode or the like at a point in time when the count time T3 has exceeded the mode transition time T2.

[0026] Next, operations of the air conditioner are explained with reference to FIG. 3. The flowchart shown in FIG. 3 is a flowchart of a control program executed by, for example, the air-conditioning control unit 5.

[0027] When the power of the air conditioner is turned on as an operation of the air conditioner is started with the operation unit 42 of the remote controller 40, the air-conditioning control unit 5 automatically executes air-conditioning control on the basis of the information from,

for example, a room temperature detection sensor (not shown) provided in the indoor unit 30. The audio processing unit 2 starts an audio recognition process by using the audio data 3a (Step S1), and the air-conditioning control unit 5 starts a detecting process on the basis of at least one of the detection information 8a and the detection information 10a (Step S2).

[0028] When the human detection unit 21 does not detect any human (NO at Step S3) and the audio processing unit 2 determines that there is no voice input (that is, no human is detected) (NO at Step S4), the absence information 5b is output, and the timer of the timer unit 9 is reset and then time counting is started (Step S5).

[0029] When the human detection unit 21 detects a human at Step S3 (YES at Step S3) or when the audio processing unit 2 determines that there is voice input (that is, a human has been detected) at Step S4 (YES at Step S4), the operation returns to Step S2 and the same processes are repeated.

[0030] After the time counting is started and before the count time T3 exceeds the notification time T1 (NO at Step S9), if the remote controller 40 is operated (YES at Step S6), if the human detection unit 21 detects a human (YES at Step S7), or if the audio processing unit 2 determines that there is voice input (YES at Step S8), the operation returns to Step S2 and the same processes are repeated. Meanwhile, after the time counting is started and when the count time T3 has exceeded the notification time T1 (YES at Step S9) in a state where the remote controller 40 is not operated (NO at Step S6), any human is not detected by the human detection unit 21 (NO at Step S7), and the audio processing unit 2 determines that there is no voice input (NO at Step S8), the audio guidance information 2b indicating shifting of the air conditioner to the power saving mode or the like is output to the audio output unit 1. With this operation, the user is notified of shifting of the air conditioner to the power saving mode or the like in advance (Step S11).

[0031] For example, when a human (user) is present in the room in which the indoor unit 30 is provided, there is also assumed a case where the user is present outside the detection range of the human detection unit 21 and no voice can be detected (such as a case where the user is reading a book in a blind spot of the human detection unit 21). However, according to the processing operation described above, even when the user present in the room in which the indoor unit 30 is provided cannot be detected by the human detection unit 21 and the audio processing unit 2 as described above, it is possible to notify the user of audio guidance indicating shifting of the air conditioner to the power saving mode or the like before the air conditioner is actually shifted to the power saving mode or the like. Therefore, the user who has heard the audio guidance can take an action such as operating the remote controller 40, moving into the detection range of the human detection unit 21, or making an utterance before the count time T3 exceeds the mode transition time T2, so as to prevent the shifting of the air conditioner to the pow-

er saving mode or the like, or more specifically, to prevent the shifting of the air conditioner to the power saving mode or the like at a timing unintended by the user.

[0032] When the count time T3 exceeds the mode transition time T2 (YES at Step S10) in a state where the remote controller 40 is not operated (NO at Step S6), any human is not detected by the human detection unit 21 (NO at Step S7), and the audio processing unit 2 determines that there is no voice input (NO at Step S8), shifting of the air conditioner to the power saving mode or the like is performed at a point in time when the count time T3 has exceeded the mode transition time T2 (Step S12).

[0033] When the remote controller 40 is operated (YES at Step S6), the human detection unit 21 detects a human (YES at Step S7), or the audio processing unit 2 determines that there is voice input (YES at Step S8) before the count time T3 exceeds the mode transition time T2 (NO at Step S10), the operation returns to Step S2 and the same processes are repeated.

[0034] As described above, for example, when a human (user) is present in the room in which the indoor unit 30 is provided, there is also assumed a case where the user is present outside the detection range of the human detection unit 21 and no voice can be detected (such as a case where the user is reading a book in a blind spot of the human detection unit 21). However, according to the processing operation described above, even when the user present in the room in which the indoor unit 30 is provided cannot be detected by the human detection unit 21 as described above, it is possible to determine the presence or absence of the user on the basis of the detection information 2a from the audio processing unit 2. Therefore, the user can be detected with higher accuracy than that in the conventional technique mentioned above. Furthermore, when the user cannot be detected by both the human detection unit 21 and the audio processing unit 2, it is possible to notify the user of audio guidance indicating shifting of the air conditioner to the power saving mode or the like before the air conditioner is actually shifted to the power saving mode or the like. Therefore, the user who has heard the audio guidance can take an action such as operating the remote controller 40, moving into the detection range of the human detection unit 21, or making an utterance before the count time T3 exceeds the mode transition time T2, so as to prevent the shifting of the air conditioner to the power saving mode or the like, or more specifically, to prevent the shifting of the air conditioner to the power saving mode or the like at a timing unintended by the user.

[0035] Although two sensors (the motion sensor 8 and the imaging unit 11) are used in the human detection unit 21 in the present embodiment, the use of only one of these sensors can also achieve identical effects as those described above. By using two sensors, the detection accuracy of the human detection unit 21 can be higher than that in the case of using only one of the motion sensor 8 or the imaging unit 11. Furthermore, although the audio input unit 3 is incorporated in the indoor unit 30 in

the present embodiment, identical effects can be achieved even when the audio input unit 3 is provided at a position other than in the indoor unit 30 and wiring for transmitting the audio data 3a is arranged between the audio processing unit 2 and the audio input unit 3.

[0036] As described above, the indoor unit 30 of the air conditioner according to the present embodiment includes a first detection unit (the audio processing unit 2), a second detection unit (the human detection unit 21), the signal reception unit 7, and the control unit 20. The first detection unit detects a human present in a space where the indoor unit 30 of an air conditioner is provided, using the audio data 3a detected by a sound collecting unit (the audio input unit 3). The second detection unit detects a human present in the space using the imaging data 11a from the imaging unit 11 that captures an image of the space. The signal reception unit 7 receives the operation signal 7a from a remote control unit (the remote controller 40) of the indoor unit 30. The control unit 20 controls an operation of the indoor unit 30 on the basis of the detection information 2a from the first detection unit, the detection information 8a from the second detection unit, and the operation signal 7a from the signal reception unit 7, and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from the audio output unit 1, when any of the detection information 2a from the first detection unit, the detection information 8a from the second detection unit, and the operation signal 7a from the signal reception unit 7 is not input before a first time (the notification time T1) elapses from a point in time when both the first detection unit and the second detection unit no longer detect any human present in the space (for example, when the count information 9a is received) after the air conditioner starts operating. With this configuration, even when the user present in the room in which the indoor unit 30 is provided cannot be detected by the human detection unit 21, it is possible to determine the presence or absence of the user on the basis of the detection information 2a from the audio processing unit 2. Therefore, the user can be detected with higher accuracy than that of the conventional technique mentioned above, and when the user cannot be detected by both the human detection unit 21 and the audio processing unit 2, it is possible to notify the user of audio guidance indicating shifting of the air conditioner to the power saving mode or the like in advance. Consequently, it is possible to prevent shifting of the air conditioner to the power saving mode or the like at a timing unintended by the user.

[0037] As the second detection unit (the human detection unit 21) is configured to detect a human present in a space where the indoor unit 30 is provided, not only using the imaging data 11a but also using the motion sensor 8, the detection accuracy of the human detection unit 21 can be made higher than that in a case of using only the imaging unit 11.

[0038] The indoor unit 30 of the air conditioner according to the present embodiment includes the first detection

unit (the audio processing unit 2), the second detection unit (the human detection unit 21), the signal reception unit 7, and the control unit 20. The second detection unit detects a human present in a space using the motion sensor 8. The control unit 20 controls an operation of the indoor unit 30 and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from the audio output unit 1, when any of the detection information 2a from the first detection unit, the detection information 8a from the second detection unit, and the operation signal 7a from the signal reception unit 7 is not input before the first time (the notification time T1) elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space (for example, when the count information 9a is received) after the air conditioner starts operating. Even with this configuration, the user can be detected with higher accuracy than that in the conventional technique, and it is possible to prevent shifting of the air conditioner to the power saving mode or the like at a timing unintended by the user.

[0039] As the second detection unit (the human detection unit 21) is configured to detect a human present in a space where the indoor unit 30 is provided, not only using the motion sensor 8 but also using the imaging data 11a from the imaging unit 11, the detection accuracy of the human detection unit 21 can be higher than that in a case of using only the motion sensor 8.

[0040] As the audio input unit 3 is incorporated in the indoor unit 30, the effects described above can be obtained. In addition, as compared to a case where the audio input unit 3 is provided at a position other than in the indoor unit 30, costs can be reduced because man-hours for wiring between the audio input unit 3 and the audio processing unit 2 are omitted.

[0041] The control unit 20 is configured to control the air conditioner to be shifted to a power saving state when any of the detection information 2a from the first detection unit, the detection information (8a, 10a) from the second detection unit, and the operation signal 7a from the signal reception unit 7 is not input before a second time (the mode transition time T2) rather than the first time (the notification time T1) elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space (for example, when the count information 9a is received) after the air conditioner starts operating. With this configuration, shifting of the air conditioner to the power saving mode or the like is still possible when the user cannot be detected by both the human detection unit 21 and the audio processing unit 2 even after audio guidance is issued, and thus it is possible to achieve energy saving without degrading user convenience.

[0042] The configuration described in the above embodiment is only an example of the configuration of the present invention. The configuration can be combined with other well-known techniques, and it is needless to mention that the present invention can be configured

while modifying it without departing from the scope of the invention, such as omitting a part of the configuration.

[0043] According to the present invention, by detecting a voice to control operations of an air conditioner, shifting of the air conditioner to a power saving mode at a timing unintended by the user is prevented. Therefore, an effect is obtained where it is possible to control operations of the air conditioner without degrading user convenience.

[0044] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. An indoor unit (30) of an air conditioner, comprising:

a first detection unit (2) that detects a human present in a space where the indoor unit of an air conditioner is provided, using audio data detected by a sound collecting unit (3);

a second detection unit (21) that detects a human present in the space using imaging data from an imaging unit (11) that captures an image of the space;

a signal reception unit (7) that receives an operation signal from a remote control unit (40) of the indoor unit; and

a control unit (20) that controls an operation of the indoor unit on a basis of detection information from the first detection unit, detection information from the second detection unit, and an operation signal from the signal reception unit, and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from an audio output unit (1), when any of the detection information from the first detection unit, the detection information from the second detection unit, and an operation signal from the signal reception unit is not input before a first time elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space after the air conditioner starts operating.

2. The indoor unit (30) of an air conditioner according to claim 1, wherein the second detection unit (21) detects a human present in the space not only using the imaging data but also using a motion sensor (8).

3. An indoor unit (30) of an air conditioner, comprising:

a first detection unit (2) that detects a human

present in a space where the indoor unit of an air conditioner is provided, using audio data detected by a sound collecting unit (3);
 a second detection unit (21) that detects a human present in the space using a motion sensor (8);
 a signal reception unit (7) that receives an operation signal from a remote control unit (40) of the indoor unit; and
 a control unit (20) that controls an operation of the indoor unit on a basis of detection information from the first detection unit, detection information from the second detection unit, and an operation signal from the signal reception unit, and causes audio guidance indicating that the air conditioner is to be shifted to a power saving state to be output from an audio output unit (1), when any of the detection information from the first detection unit, the detection information from the second detection unit, and an operation signal from the signal reception unit is not input before a first time elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space after the air conditioner starts operating.

4. The indoor unit (30) of an air conditioner according to claim 3, wherein the second detection unit (21) detects a human present in the space not only using the motion sensor (8) but also using imaging data from an imaging unit (11) that captures an image of the space.
5. The indoor unit (30) of an air conditioner according to any one of claims 1 to 4, wherein the sound collecting unit (3) is incorporated in the indoor unit.
6. The indoor unit (30) of an air conditioner according to any one of claims 1 to 5, wherein the control unit (20) controls the air conditioner to be shifted to a power saving state when any of the detection information from the first detection unit (2), the detection information from the second detection unit (21), and the operation signal from the signal reception unit (7) is not input before a second time rather than the first time elapses from a point in time when both the first detection unit and the second detection unit no longer detect a human present in the space after the air conditioner starts operating.

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FIG.1

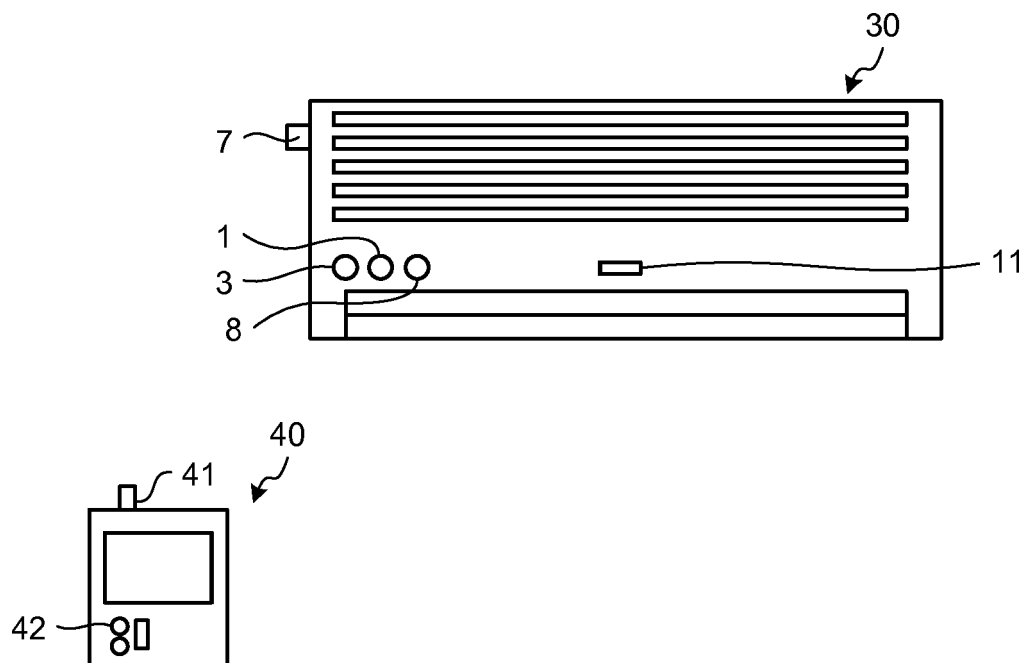


FIG.2

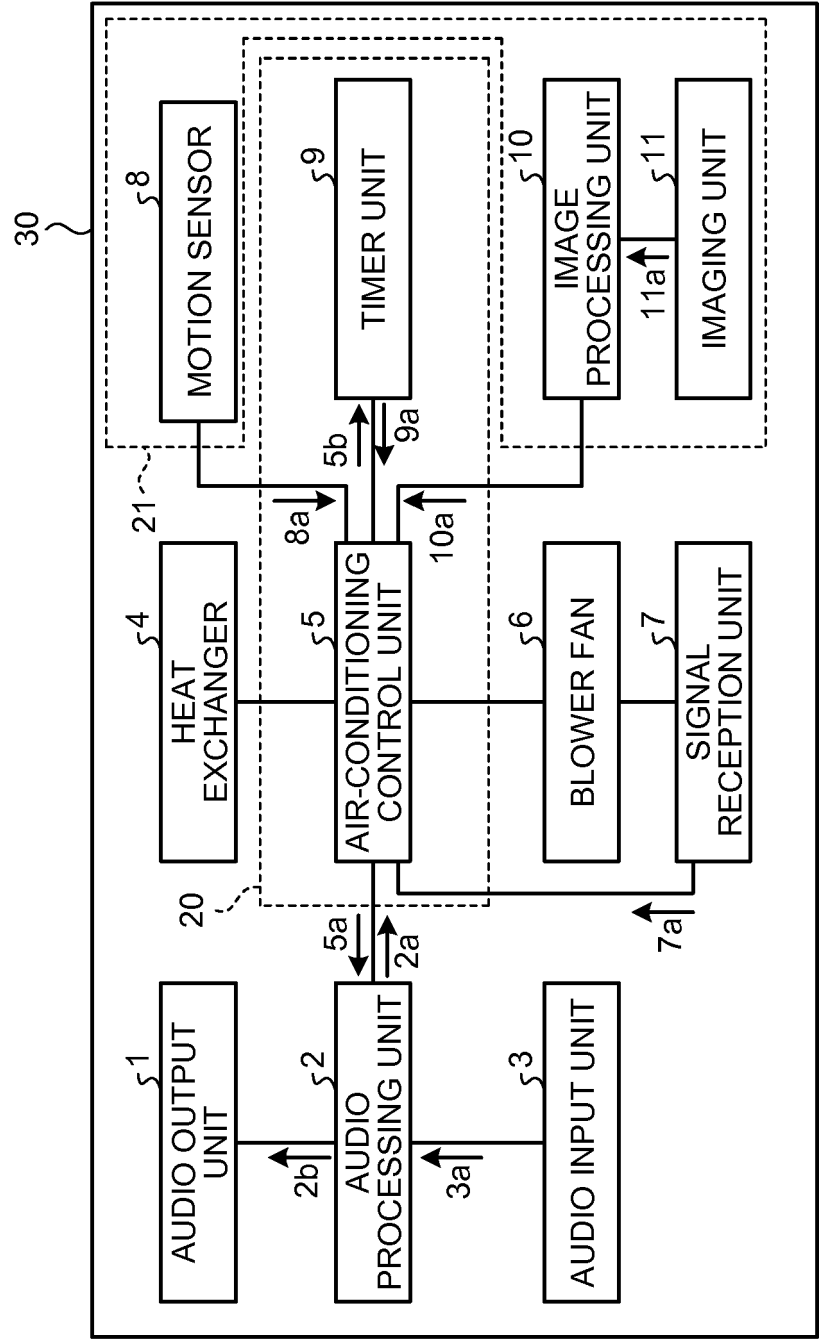
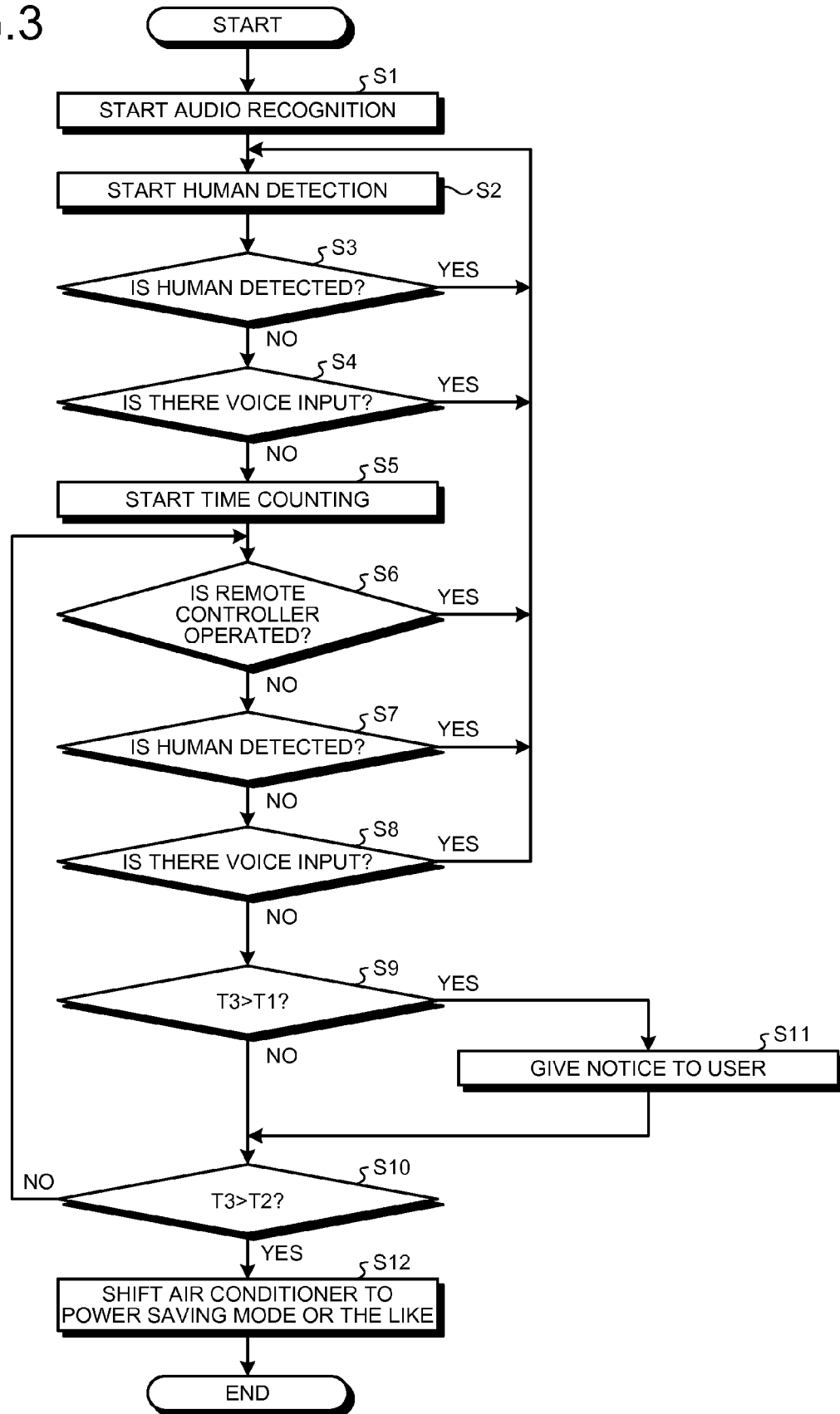


FIG.3



REFERENCES CITED IN THE DESCRIPTION

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