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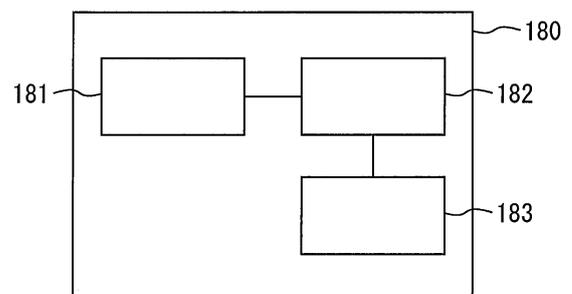
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(54) **AIR CONDITIONING DEVICE**

(57) An air conditioning device capable of performing air blow control with taken into account the surface temperature of a site of a human body hidden by an obstacle such as furniture and appropriately blowing conditioned air to the human body of a user is provided. To achieve this, the air conditioning device includes: an air blow mechanism capable of changing the direction of conditioned air blown out through an air outlet port; a temperature sensor configured to detect surface temperature in a predetermined detection range; a human body identify part configured to detect a human body based on a result of the detection by the temperature sensor and identify a region in which the detected human body exists; a floor temperature sensor configured to detect floor temperature; an estimated temperature calculator configured to identify a site of the human body in which the temperature of the human body is not detected by the temperature sensor in the region in which the human body exists and calculate an estimated temperature value of the identified site of the human body based on a result of the detection by the temperature sensor and a result of the detection by the floor temperature sensor; and an air blow control unit configured to control the air blow mechanism based on the estimated temperature value of the site of the human body.

FIG. 7



180: CONTROL DEVICE
181: HUMAN BODY IDENTIFY PART
182: ESTIMATED TEMPERATURE CALCULATOR
183: AIR BLOW CONTROL UNIT

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Description

Field

[0001] The present invention relates to an air conditioning device.

Background

[0002] A conventionally known air conditioning device (refer to PTL 1, for example) includes, for example, a person number detection unit configured to detect the number of persons, a human body position detection unit configured to detect the position of each person, a foot temperature sensor configured to detect a foot temperature, and a floor-wall temperature sensor configured to detect the temperatures of a floor and a wall. The air conditioning device performs controls to calculate radiation temperature near each person based on the position of the human body, the foot temperature, and the floor-wall temperature, calculate the degree of comfort of each person existing in a room based on, for example, the radiation temperature, and determine a wind direction based on the number of persons, the position of each person, the degree of comfort, and an operation mode.

Citation List

Patent Literature

[0003] [PTL 1] JP H06-288598 A

Summary

Technical Problem

[0004] However, the conventional air conditioning device disclosed in PTL 1 cannot detect information necessary for control, in particular, a foot temperature due to an obstacle such as furniture placed in a room, which makes it difficult to blow appropriate conditioned air to the human body of a user, and potentially leads to a reduced comfortable feeling of the user.

[0005] The present invention is intended to solve the above-described problem by providing an air conditioning device capable of performing air blow control with taken into account the surface temperature of the human body of a user, appropriately blowing conditioned air to the human body of the user, and improving a comfortable feeling of the user when there is an obstacle such as furniture.

Solution to Problem

[0006] An air conditioning device according to the present invention includes: a housing having an air intake port and an air outlet port; a heat exchanger arranged in the housing, the heat exchanger configured to exchange

heat with air sucked from the air intake port to generate conditioned air; an air blow mechanism provided to the housing, the air blow mechanism configured to generate air flow which sucks air from the air intake port and blows out the conditioned air from the air outlet port, and capable of changing a direction of the conditioned air which blows from the air outlet port; a temperature sensor configured to detect surface temperature in a predetermined detection range; a human body identify part configured to detect a human body and to identify a region in which the detected human body exists based on a detection result of the temperature sensor; a floor temperature sensor configured to detect floor temperature; an estimated temperature calculator configured to identify a site in which temperature of the human body is not detected by the temperature sensor in the region in which the human body exists, and to calculate an estimated value of temperature of the identified site of the human body based on the detection result of the temperature sensor and a detection result of the floor temperature sensor; an air blow control unit configured to control the air blow mechanism based on the estimated value of temperature of the site of the human body.

[0007] Alternatively, an air conditioning device according to the present invention includes: a housing having an air intake port and an air outlet port; a heat exchanger arranged in the housing, the heat exchanger configured to exchange heat with air sucked through the air intake port to generate conditioned air; an air blow mechanism provided to the housing, the air blow mechanism configured to generate air flow which sucks air from the air intake port and blows out the conditioned air from the air outlet port, and capable of changing the direction of the conditioned air blown out from the air outlet port; a temperature sensor configured to detect surface temperature in a predetermined detection range; a floor temperature sensor configured to detect floor temperature; and an air blow control unit configured to control, when the temperature in a site of a foot or a hand of a human body is not detected by the temperature sensor and the floor temperature is lower than the temperature of air sucked through the air intake port, the air blow mechanism so that the direction of conditioned air points to the position of the human body.

Advantageous Effects of Invention

[0008] An air conditioning device according to the present invention is capable of performing, when there is an obstacle such as furniture, air blow control with taken into account the surface temperature of a site of the human body of a user hidden behind the obstacle, appropriately blowing conditioned air to the human body of the user, and improving a comfortable feeling of the user.

Brief Description of Drawings

Brief Description of the Drawings

[0009]

Fig. 1 is an external perspective view of an air conditioning device according to the Embodiment 1 of the present invention.

Fig. 2 is a longitudinal sectional view of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 3 is a diagram for description of the detection range of a human body sensor included in the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 4 is a diagram for description of the detection range of the human body sensor in a depth direction of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 5 is a diagram for description of the detection range of the human body sensor in a horizontal direction of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 6 is a block diagram illustrating the configuration of a control system of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 7 is a block diagram illustrating a functional configuration of a control device of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 8 is a flowchart of air blow control in a heating operation of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 9 is a diagram illustrating an exemplary adjusted R-squared value of a warm-cold feeling calculation formula used in the heating operation of the air conditioning device according to the Embodiment 1 of the present invention.

Fig. 10 is a flowchart of air blow control of the air conditioning device according to the Embodiment 2 of the present invention in the heating operation.

Fig. 11 is a diagram illustrating an exemplary adjusted R-squared value of the warm-cold feeling calculation formula used in the heating operation of the air conditioning device according to the Embodiment 2 of the present invention.

Fig. 12 is a flowchart of air blow control of the air conditioning device according to the Embodiment 3 of the present invention in the heating operation.

Fig. 13 is a flowchart of air blow control of the air conditioning device according to the Embodiment 4 of the present invention in the heating operation.

Description of Embodiments

[0010] Embodiments of the present invention will be

described below with reference to the accompanying drawings. In the drawings, parts identical or equivalent to each other are denoted by an identical reference sign, and duplicate description thereof will be simplified or omitted as appropriate. The present invention is not limited to the embodiments described below but may be modified in various manners without departing from the scope of the present invention.

5
10 Embodiment 1

[0011] Figs. 1 to 8 illustrate Embodiment 1 of the present invention. Fig. 1 is an external perspective view of an air conditioning device. Fig. 2 is a longitudinal sectional view of the air conditioning device. Fig. 3 is a diagram for description of the detection range of a human body sensor included in the air conditioning device. Fig. 4 is a diagram for description of the detection range of the human body sensor in a depth direction of the air conditioning device. Fig. 5 is a diagram for description of the detection range of the human body sensor in a horizontal direction of the air conditioning device. Fig. 6 is a block diagram illustrating the configuration of a control system of the air conditioning device. Fig. 7 is a block diagram illustrating a functional configuration of a control device of the air conditioning device. Fig. 8 is a flowchart of air blow control in a heating operation of the air conditioning device. Fig. 9 is a diagram illustrating an exemplary adjusted R-squared value of a warm-cold feeling calculation formula used in the heating operation of the air conditioning device.

[0012] An air conditioning device 100 in Embodiment 1 of the present invention is an indoor unit of an air conditioner. Thus, the air conditioning device 100 is installed on a wall surface or ceiling surface in a room. This example assumes that the air conditioning device 100 is installed on a wall surface in a room.

[0013] As illustrated in Figs. 1 and 2, the air conditioning device 100 includes a housing 110. The housing 110 of the air conditioning device 100 is formed in a horizontally long substantially rectangular parallelepiped shape having a smooth curved surface extending from a front surface to a lower surface. An air intake port 111 is formed at an upper surface of the housing 110. The air intake port 111 is an opening through which air is acquired from the outside to the inside of the housing 110. An air outlet port 112 is formed at a lower part of the front surface of the housing 110. The air outlet port 112 is an opening through which air is discharged from the inside of the housing 110 to the outside. A front surface panel 113 covers an upper part of the front surface of the housing 110.

[0014] Vertical deflectors 131, 132, 141, and 142 are provided at the air outlet port 112. These vertical deflectors are used to adjust the vertical blow-out angle of air blown out through the air outlet port 112.

[0015] The vertical deflectors are installed on the front and back sides when the air conditioning device 100 is

squarely viewed. The vertical deflectors on each of the front and back sides are provided in a divided manner on the right and left sides. Specifically, the divided vertical deflectors on the front side are the front-left side vertical deflector 131 on the left side and the front-right side vertical deflector 132 on the right side when the air conditioning device 100 is squarely viewed. The divided vertical deflectors on the back side are the back-left side vertical deflector 141 on the left side and the back-right side vertical deflector 142 on the right side when the air conditioning device 100 is squarely viewed.

[0016] The position at which the right and left vertical deflectors are divided from each other on each of the front and back sides is substantially at the center in a longitudinal direction (right-left direction of the air outlet port 112) when the air conditioning device 100 is squarely viewed. The front-left side vertical deflector 131 and the front-right side vertical deflector 132 have a slight gap therebetween. Similarly, the back-left side vertical deflector 141 and the back-right side vertical deflector 142 have a slight gap therebetween.

[0017] The front-left side vertical deflector 131, the front-right side vertical deflector 132, the back-left side vertical deflector 141, and the back-right side vertical deflector 142 are plate members narrowly extending in the right-left direction of the air outlet port 112. The vertical deflectors 131, 132, 141, and 142 are each curved to have an arc section vertical to the longitudinal direction.

[0018] The vertical deflectors 131, 132, 141, and 142 are each attached to the housing 110 through a support arm (not illustrated). Each support arm is attached rotatably relative to the housing 110. The orientation of each vertical deflector can be changed by rotating the support arm relative to the housing 110. Then, the air conditioning device 100 can vertically change an air blow direction by changing the orientation of each vertical deflector.

[0019] The support arm of each vertical deflector is provided so that the angle thereof can be adjusted through drive of a vertical deflector stepping motor. Specifically, in this example, the orientations of the front-left side vertical deflector 131 and the back-left side vertical deflector 141 are changed by a left side vertical deflector stepping motor 161. The orientations of the front-right side vertical deflector 132 and the back-right side vertical deflector 142 are changed by a right side vertical deflector stepping motor 162.

[0020] A vertical blow-out angle (air blow direction) of air blown out on the left side of the air outlet port 112 and a vertical blow-out angle (air blow direction) of air blown out on the right side of the air outlet port 112 can be separately adjusted in this manner. Figs. 1 and 2 omit illustration of the left side vertical deflector stepping motor 161 and the right side vertical deflector stepping motor 162.

[0021] A right-left deflector 150 is provided on the back side of the vertical deflectors 131, 132, 141, and 142 at the air outlet port 112. The right-left deflector 150 is used to adjust a right-left blow-out angle of air blown out

through the air outlet port 112. The right-left deflector 150 includes a plurality of plates arranged in the longitudinal direction (right-left direction of the air outlet port 112) when the air conditioning device 100 is squarely viewed. Similarly to the vertical deflectors 131, 132, 141, and 142, the right-left deflector 150 is attached so that the angle thereof can be adjusted through drive of a right-left deflector stepping motor 163 (not illustrated in Figs. 1 and 2).

[0022] An air path extending from the air intake port 111 to the air outlet port 112 is formed in the housing 110. A heat exchanger 121 is installed downstream of the air intake port 111 on the air path. The heat exchanger 121 heats or cools the air flowing through the air path through heat exchange with the air. The air is heated or cooled depending on whether the air conditioning device 100 is in a heating operation or a cooling operation. Specifically, in the heating operation, the heat exchanger 121 heats the air. In the cooling operation, the heat exchanger 121 cools the air.

[0023] The heat exchanger 121 heats or cools air flowing through the air path to adjust the temperature, humidity, and the like of the air, thereby generating conditioned air. In this manner, the heat exchanger 121 generates conditioned air through heat exchange with air sucked through the air intake port 111. The generated conditioned air is warm air in the heating operation, or cold air in the cooling operation.

[0024] An air blow fan 122 is installed downstream of the heat exchanger 121 on the air path. The air blow fan 122 is used to generate, in the air path, air flow from the air intake port 111 to the air outlet port 112.

[0025] When the air blow fan 122 is operated, air flow from the air intake port 111 to the air outlet port 112 is generated in the air path, air is sucked through the air intake port 111, and air is blown out through the air outlet port 112. The air sucked through the air intake port 111 becomes air flow passing through the heat exchanger 121 and the air blow fan 122 in the stated order on the air path in the air conditioning device 100, and blown out through the air outlet port 112. In this case, the direction (air blow direction) of wind blown out through the air outlet port 112 is adjusted (changed) by the vertical deflectors 131, 132, 141, and 142 and the right-left deflector 150, which are disposed downstream of the air blow fan 122.

[0026] The air blow fan 122, the vertical deflectors 131, 132, 141, and 142, the right-left deflector 150, the vertical deflector stepping motors 161 and 162, and the right-left deflector stepping motor 163 are included in an air blow mechanism provided to the housing 110. The air blow mechanism thus configured can generate air flow that sucks air through the air intake port 111 and blows out conditioned air through the air outlet port 112, and change the direction of the conditioned air blown out through the air outlet port 112.

[0027] A human body sensor 170 is attached at the center of a front surface of the air conditioning device 100. However, the attachment position of the human

body sensor 170 is not limited to the center of the front surface of the air conditioning device 100. The human body sensor 170 may be attached at, for example, an end part on the left or right side of the housing 110.

[0028] The human body sensor 170 includes, for example, a plurality of infrared sensors (light-receiving elements) arranged in the vertical direction. This example assumes that the human body sensor 170 includes eight infrared sensors (light-receiving elements). These eight infrared sensors are detection elements capable of individually performing infrared light reception and temperature detection. For example, the infrared sensors (light-receiving elements) are arranged straight in the vertical direction inside a cylindrical metal can 171 as illustrated in Fig. 3. Accordingly, the human body sensor 170 has the function of detecting indoor temperature in a divided manner in eight areas at heights different from each other.

[0029] The detection ranges of the respective eight infrared sensors are set as rectangular areas having sizes equal to each other as illustrated in Fig. 3. Each infrared sensor is set to have, for example, a vertical distributive view angle of 7° in the vertical direction and a horizontal distributive view angle of 8° in the right-left direction.

[0030] A distributive view angle 173 of the entire human body sensor 170 as the sum of the distributive view angles of the infrared sensors is set as an area elongated in the vertical direction. The distributive view angles (detection ranges) of the infrared sensors do not necessarily need to have identical shapes nor identical sizes. Specific values of the vertical and horizontal distributive view angles are not limited to the above-described exemplary values. The number of infrared sensors (light-receiving elements) is not limited to eight, but the human body sensor 170 may include infrared sensors (light-receiving elements) in an optional number equal to or smaller than seven or equal to or larger than nine.

[0031] The human body sensor 170 can change, through a sensor stepping motor 172 (not illustrated in Figs. 1 and 2), the orientations of the plurality of vertically arranged infrared sensors to right and left in a predetermined angle range. Thus, the plurality of vertically arranged infrared sensors can be each scanned in the right-left direction to detect surface temperature in a predetermined detection range (hereinafter referred to as a "temperature detection target range") on the front side of the air conditioning device 100.

[0032] With this configuration, the human body sensor 170 acquires surface temperature distribution (heat image) in the temperature detection target range in a non-contact manner by scanning through the range. In other words, the human body sensor 170 serves as a temperature sensor configured to detect surface temperature in the predetermined detection range. When the temperature detection target range includes a floor surface, the surface temperature detected by the infrared sensors included in the human body sensor 170 is the temperature of the floor surface, in other words, floor temperature.

Thus, in this example, the human body sensor 170 also serves as a floor temperature sensor configured to detect floor temperature. However, another floor temperature sensor configured to detect floor temperature may be provided in addition to the infrared sensors included in the human body sensor 170.

[0033] The existence and position of a heat source including a person in the room, the surface temperature of a human body, and a site (such as an exposed or non-exposed part of skin or the head) of the human body, and the like can be detected based on, for example, a temperature difference from the background by processing, through a control device 180 to be described later or the like, a result of the detection by the human body sensor 170, in other words, surface temperature distribution (heat image) data acquired by the human body sensor 170.

[0034] In addition, the sensible temperature of a person in the room can be obtained based on a result of the detection by the human body sensor 170. In this case, it is easier to detect the sensible temperature of a human body having skin exposed. The human body sensor 170 has a higher detection accuracy as the number of pixels of each light-receiving element included in the human body sensor 170 is larger. Specifically, for example, when the light-receiving element includes 30 pixels or more, it is possible to accurately detect the position of a person in the room and the distance from the human body sensor 170 to the person.

[0035] The human body sensor 170 detects the temperature of a temperature detection target while scanning the temperature detection target range to right and left directions. The right and left directions are right and left directions when viewed from the air conditioning device 100. To acquire heat image data (temperature distribution data) of a wall and a floor in the room, for example, the orientation of the human body sensor 170 is moved in the right-left direction by the sensor stepping motor 172, and rotation of the sensor stepping motor 172 (in other words, rotation of the orientation of the human body sensor 170) is stopped at each constant angle for a constant time. The constant angle is, for example, 1 to 5°. The constant time is, for example, 0.1 to 0.2 seconds. Then, after the change of the orientation of the human body sensor 170 is stopped followed by a wait for a time shorter than the constant time (0.1 to 0.2 seconds), a result (heat image data) of the detection by the eight light-receiving elements of the human body sensor 170 is acquired.

[0036] After the result of the detection by the human body sensor 170 is acquired, the sensor stepping motor 172 is rotated again by the constant angle and stopped again, and a result (heat image data) of the detection by the human body sensor 170 is acquired through the same operation. Such an operation is repeated to acquire a result of the detection by the human body sensor 170 at each of, for example, 90 to 100 places in the right-left direction in the detection range. Then, heat image data

(temperature distribution data) of the temperature detection target range can be obtained based on the acquired results of the detection by the human body sensor 170.

[0037] The following describes the detection range of the human body sensor 170 configured as described above with reference to Figs. 4 and 5. Fig. 4 is a diagram for description of the detection range of the human body sensor 170 in the depth direction when viewed from the air conditioning device 100. Fig. 4 illustrates the state of the inside of a room in which the air conditioning device 100 is installed when viewed in the horizontal direction. In the state exemplarily illustrated in Fig. 4, the air conditioning device 100 is installed at the height of 1800 mm approximately, and the distance from the air conditioning device 100 to a human body is 3600 mm approximately.

[0038] The detection range of the human body sensor 170 is divided in the depth direction into a plurality of regions in a number equal to the number of (in this example, eight) infrared sensors (light-receiving elements). In other words, the internal space of the room is divided in the depth direction into eight regions corresponding to the distributive view angles of the respective light-receiving elements. Then, the size of each divided region is set in accordance with a spread angle of the distributive view angle in the vertical direction.

[0039] The lowermost light-receiving element of the human body sensor 170 detects a human body in a front-side region closest to the air conditioning device 100. An upper light-receiving element of the human body sensor 170 detects a human body in a farther region.

[0040] Fig. 5 is a diagram for description of the detection range of the human body sensor 170 in the right-left direction when viewed from the air conditioning device 100. Fig. 5 illustrates the state of the inside of the room in which the air conditioning device 100 is installed when viewed from above. The detection range of the human body sensor 170 is divided in the right-left direction into a plurality of regions at each constant angle when the human body sensor 170 is rotated by the sensor stepping motor 172.

[0041] Fig. 5 illustrates an example in which the detection range of the human body sensor 170 in the right-left direction is set to be 90° approximately. The detection range of the human body sensor 170 in the right-left direction is not limited to this angle. For example, the human body sensor 170 may be configured to completely rotate one revolution by the sensor stepping motor 172, and the detection range may be set to be 360°.

[0042] The human body sensor 170 may be swung also in the vertical direction by another stepping motor or the like. When the orientation of the human body sensor 170 can be changed also in the vertical direction, detailed heat image data can be acquired in the vertical direction as well as the horizontal direction.

[0043] The human body sensor 170 may include an infrared sensor and another detection instrument. For example, a camera or an ultrasonic wave sensor may be used to detect the position and shape of a human body

and the distance to the human body. In other words, the human body sensor 170 may further include, in addition to an infrared sensor, for example, an ultrasonic wave sensor capable of detecting an object. With this configuration, the human body sensor 170 can detect the position of a human body and the distance thereto at an increased accuracy. Alternatively, a pyroelectric sensor including a Fresnel lens may be used to detect the position of a human body in the room in the right-left direction and the depth direction (front-back direction) when viewed from the air conditioning device 100.

[0044] The following describes the configuration of the control system of the air conditioning device 100 with reference to Fig. 6. The air conditioning device 100 includes the control device 180 and an operation unit 190. The control device 180 is achieved by an electric circuit including, for example, a micro computer. The control device 180 includes a processor and a memory. The memory stores therein a control program. The processor reads and executes the program stored in the memory.

[0045] When the processor executes the control program, the control device 180 executes predetermined processing to control operation of the air conditioning device 100. In particular, when the processor executes the program stored in the memory, the functions of a human body identify part 181, an estimated temperature calculator 182, and an air blow control unit 183 to be described later are achieved.

[0046] The control device 180 has an input side connected with a sensor system including, for example, the human body sensor 170. The control device 180 has an output side connected with various actuators including, for example, the air blow fan 122, the left side vertical deflector stepping motor 161, the right side vertical deflector stepping motor 162, the right-left deflector stepping motor 163, and the sensor stepping motor 172.

[0047] The control device 180 is connected with the operation unit 190 including, for example, a remote controller to perform mutual communication therebetween.

A user operates the operation unit 190 to, for example, turn power on and off, perform switching between the heating operation and the cooling operation, and perform settings of temperature, wind direction, air volume, and the like. The control device 180 controls the operation of the air conditioning device 100 by driving the actuators based on inputs from the sensor system and the operation unit 190. Examples of control executed by the control device 180 include control of the cooling operation, the heating operation, an air blow operation, and an operation of scanning the human body sensor 170.

[0048] As illustrated in Fig. 7, the control device 180 includes the human body identify part 181, the estimated temperature calculator 182, and the air blow control unit 183. The human body identify part 181 detects a human body existing in the temperature detection target range of the human body sensor 170 based on a result of the detection by the human body sensor 170 as the temperature sensor. The detection of a human body can be per-

formed by using, for example, the shape, distribution (relative positional relation), and area of each region, the surface temperature of which detected by the human body sensor 170 is equal to or higher than a predetermined reference temperature. Specifically, the reference temperature is set to be, for example, 30°C with the body temperature of a human body taken into account.

[0049] Subsequently, the human body identify part 181 identifies a region in which a human body detected in this manner exists. The region in which a human body exists can be identified by using, for example, the shape, distribution (relative positional relation), and area of each region having a surface temperature equal to or higher than a certain temperature, and the relative magnitude relation between the temperatures of the regions. The region in which a human body exists, which is identified by the human body identify part 181, may include a part, the surface temperature of which detected by the human body sensor 170 is lower than the reference temperature. When the region in which a human body exists is identified, the shape of the region is identified, in other words, the shape of the human body is identified. Thus, "identify a region in which a human body exists" can be rephrased as "identify the shape of a human body".

[0050] The human body identify part 181 may identify the entire region in which a human body exists all at once, or may individually identify a region in which a human body exists for each site of the human body. When the region in which each site of the human body exists is individually identified, the human body identify part 181 identifies, for example, regions in which the head, the chest, an arm, an upper leg, a lower leg, a hand, and a foot of the human body exist. The "hand" herein is a part on the leading end side of the wrist. The "foot" herein is a part on the leading end side of the ankle.

[0051] In this case, the human body identify part 181 may identify, in particular, a part, the surface temperature of which detected by the human body sensor 170 is equal to or higher than a predetermined temperature, as a region in which at least one of the head, chest, and abdomen of the human body exists. When identifying each region in which a site of the human body exists, the human body identify part 181 may also identify the temperature, the position, and a clothing state of each site. The "clothing state" is a state related to whether skin at the site is covered by clothes or the like, or exposed.

[0052] When the human body sensor 170 includes an ultrasonic wave sensor in addition to an infrared sensor configured to detect surface temperature, the human body identify part 181 may detect a human body based on a result of detection by the infrared sensor and a result of detection by the ultrasonic wave sensor, and identify a region in which the detected human body exists.

[0053] The identification of each region in which a site of a human body exists by the human body identify part 181 will be described below by using a specific example with reference to Fig. 4 again. In the example illustrated in Fig. 4, a human body is detected in the detection re-

gions of the uppermost to fourth (four) light-receiving elements.

[0054] Specifically, the uppermost light-receiving element detects the head of a human body. The head is exposed, and has a skin temperature higher than that at the other part of the human body, for example, a skin temperature equal to or higher than 30°C. Thus, the human body identify part 181 can identify a region to which the head of the human body belongs based on heat image data acquired by the human body sensor 170. More specifically, the human body identify part 181 analyzes heat image data acquired by the uppermost light-receiving element through scanning in the horizontal direction. Then, when the shape of a heat source having a detected temperature equal to or higher than 30°C matches with the shape (for example, a circular shape) of a human head stored in advance in the horizontal direction, the heat source is identified as a head.

[0055] The second light-receiving element detects the chest and an arm of a human body. The chest is covered by clothes in most cases, and skin is hardly exposed there. Skin of the arm is exposed or not exposed, depending on cases. The human body identify part 181 can determine whether the arm is exposed based on surface temperature detected by the human body sensor 170. Specifically, when skin of the arm is exposed, a skin temperature equivalent to or slightly lower than that of the head is detected at the position corresponding to the arm. This is because the arm is colder than the head in some cases, and in such a case, the temperature of the arm is detected to be lower than that of the head.

[0056] The third light-receiving element detects an upper leg of a human body. The upper leg is covered by clothes in most cases. Thus, the surface temperature of clothes is detected at the position corresponding to the upper leg. The surface temperature of clothes is lower than the temperature of skin. When a hand is placed beside the upper leg, a temperature equivalent to or lower than that of the head is detected at the position of the hand. The hand is colder than the head in some cases. In such a case, a temperature lower than that of the head is detected at the position of the hand.

[0057] The fourth light-receiving element detects a lower leg of a human body. When the human body wears clothes such as socks, the surface temperature of clothes is detected at the position of the lower leg. When the foot is cold, a temperature lower than the surface temperature of clothes is detected at the position corresponding to the lower leg whether or not clothes are worn.

[0058] Similarly to the head of a human body, for each site of the chest, an arm, an upper leg, a lower leg, a hand, and a foot of the human body, the human body identify part 181 identifies a region in which the site exists by comparing the shape of a region having a temperature equal to or higher than a certain temperature with the shape of the site stored in advance.

[0059] The description continues with reference to Fig. 7 again. The estimated temperature calculator 182 first

identifies, in a region in which a human body exists, which is identified by the human body identify part 181, a site of the human body in which the temperature of the human body is not detected by the human body sensor 170. Hereinafter, a site of a human body in which the temperature is not detected by the human body sensor 170 is referred to as a "temperature undetected site". This temperature undetected site is a site in which the temperature of a human body cannot be detected by the human body sensor 170 due to, for example, clothes on the human body and an obstacle such as furniture placed in the room.

[0060] For example, the estimated temperature calculator 182 identifies, as a temperature undetected site, a part of a region in which a human body exists, which is identified by the human body identify part 181, the part having a temperature lower than the above-described reference temperature by a certain temperature or more. Alternatively, for example, the estimated temperature calculator 182 identifies, as a temperature undetected site, a part of a region in which a human body exists, which is identified by the human body identify part 181, the part having a temperature different from the surface temperature outside the region by a certain temperature or less. Alternatively, when a region in which a human body exists is individually identified for each site of the human body by the human body identify part 181, the estimated temperature calculator 182 may identify, as a temperature undetected site, a region in which one or both of a foot and a lower leg of the human body identified by the human body identify part 181 exist.

[0061] Subsequently, the estimated temperature calculator 182 calculates an estimated temperature value of the identified temperature undetected site. The estimated temperature calculator 182 performs this calculation of the estimated temperature value of the temperature undetected site based on a result of the detection by the temperature sensor and a result of the detection by the floor temperature sensor. In this example, the human body sensor 170 also serves as the temperature sensor and the floor temperature sensor as described above. Thus, in the example described in Embodiment 1, the estimated temperature calculator 182 calculates the estimated temperature value of the temperature undetected site based on a result of the detection by the human body sensor 170.

[0062] For example, the estimated temperature calculator 182 calculates the estimated value of the temperature undetected site of the human body based on the floor temperature around the human body and the temperature of the site of the human body, the temperature of which is detected by the human body sensor 170. For this calculation, the memory of the control device 180 stores therein in advance a relational expression that calculates the temperature of an optional site of a human body based on the floor temperature around the human body and the temperature of a site such as the head of the human body, the skin temperature of which is likely

to be detected. Then, the estimated temperature calculator 182 calculates the estimated temperature value of the temperature undetected site of the human body based on the detected floor temperature and the detected temperature of the human body by using the relational expression.

[0063] When the temperature undetected site is a site such as a foot close to the floor, the estimated temperature value of the foot as the temperature undetected site may be calculated based on the floor temperature only. Specifically, in such a case, a relational expression of the floor temperature around the human body and the foot temperature of the human body is stored in the memory of the control device 180 in advance. Then, the estimated te

(EN) Provided is an air conditioning device that can perform blowing control which takes into account the surface temperature of part of a person's body that is hidden by an obstruction such as a piece of furniture, and that can appropriately blow conditioned air onto the body of a user. Accordingly, this air conditioning device is configured to comprise: a blowing mechanism that can change the wind direction of conditioned air blown out from a blowing out port; a temperature detecting means that detects a surface temperature within a preset detection range; a person's body identifying unit that detects a person's body and identifies a region in which the detected person's body exists on the basis of a detection result of the temperature detecting means; a floor temperature detecting means that detects a floor temperature; an estimated temperature calculating unit that identifies a part of the person's body for which the temperature of the person's body is not detected by the temperature detecting means in the region in which the person's body exists, and calculates an estimated value of the temperature of the identified part of the person's body on the basis of the detection result of the temperature detecting means and a detection result of the floor temperature detecting means; and a blowing control unit that controls the blowing mechanism on the basis of the estimated value of the temperature of the part of the person's body. mperature calculator 182 calculates the estimated foot temperature value of the human body based on the detected floor temperature by using this relational expression.

[0064] The air blow control unit 183 controls the above-described air blow mechanism based on the estimated temperature value of a site of a human body, which is calculated by the estimated temperature calculator 182 as described above. Specific contents of control of the air blow mechanism based on the estimated temperature value of a temperature undetected site will be described below for each case of the heating operation and the cooling operation. The control of the air blow mechanism based on the estimated temperature value of a temperature undetected site to be described below may be performed in only one or both of the heating operation and the cooling operation.

[0065] The following first describes the case of the

heating operation. When the estimated temperature value of a site of a human body, which is calculated by the estimated temperature calculator 182 is lower than a heating reference temperature in the heating operation, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points to the position of the human body. When the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator 182 is higher than the heating reference temperature in the heating operation, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points in a direction away from the position of the human body, thereby performing what is called "human-avoiding air blow".

[0066] In this case, the air blow mechanism is desirably controlled so that the distance between the human body and conditioned air airflow is equal to or longer than 0.3 m. The shortest distance between conditioned air airflow and the human body is preferably set to be equal to or longer than 0.3 m. With this setting, when conditioned air airflow spreads to some extent, the airflow can be sufficiently prevented from reaching the human body.

[0067] The air blow control unit 183 calculates the heating reference temperature based on a result of the detection by the temperature sensor and a result of the detection by the floor temperature sensor. In this example, the human body sensor 170 also serves as the temperature sensor and the floor temperature sensor as described above. Thus, in the example described in Embodiment 1, the air blow control unit 183 calculates the heating reference temperature based on the temperature of the human body detected by the human body sensor 170 and the floor temperature detected by the human body sensor 170.

[0068] Specifically, the heating reference temperature is calculated as the sum of the product of the temperature of the upper body among the temperature of the human body detected by the human body sensor 170 and a weighting coefficient and the product of the floor temperature around the human body detected by the human body sensor 170 and a weighting coefficient. The detection of the upper body of the human body by the human body sensor 170 is unlikely to be interrupted by an obstacle such as furniture in the room as compared to the lower body. Thus, the heating reference temperature can be stably calculated by using the temperature of the upper body.

[0069] The difference between the floor temperature around the human body and the temperature of a foot of the human body may be used instead of directly using the floor temperature. In this case, when the temperature of the foot of the human body can be directly detected by the human body sensor 170, the value detected by the human body sensor 170 is used. When the foot of the human body is a temperature undetected site, the estimated temperature value of the foot of the human body calculated by the estimated temperature calculator

182 is used.

[0070] The weighting coefficients are determined in advance and stored in the memory of the control device 180 or the like in advance. When used, the weighting coefficients are read. The weighting coefficient that multiplies the temperature of the human body and the weighting coefficient that multiplies the floor temperature are separately set. Specifically, the upper body is preferably, for example, the head, the chest, or the abdomen as described above. This is because hands and arms are often used in life, and the temperatures thereof are likely to vary by movement and thus preferably avoided from being directly used to calculate the heating reference temperature.

[0071] In some cases, a plurality of human bodies are detected in the room, and the estimated temperature values of temperature undetected sites of two or more of the human bodies are lower than the heating reference temperature. In such a case, the air blow control unit 183 may control the air blow mechanism so that the direction of conditioned air points to a middle place among the two or more human bodies, the estimated temperature values of the temperature undetected sites of which are lower than the heating reference temperature.

[0072] The following describes the case of the cooling operation. When the estimated temperature value of a site of a human body, which is calculated by the estimated temperature calculator 182, is higher than a cooling reference temperature in the cooling operation, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points to the position of the human body. When the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator 182, is lower than the cooling reference temperature in the cooling operation, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points in a direction away from the position of the human body, thereby performing what is called "human-avoiding air blow". In this case, similarly to the case of the heating operation, the air blow mechanism is desirably controlled so that the distance between the human body and conditioned air airflow is equal to or longer than 0.3 m.

[0073] Similarly to the heating reference temperature described above, the cooling reference temperature is calculated based on a result of the detection by the temperature sensor and a result of the detection by the floor temperature sensor. Specifically, in the example described in Embodiment 1, the air blow control unit 183 calculates the cooling reference temperature based on the temperature of the human body detected by the human body sensor 170 and the floor temperature detected by the human body sensor 170.

[0074] Specifically, the cooling reference temperature is calculated as the sum of the product of the temperature of the upper body among the temperature of the human body detected by the human body sensor 170 and a weighting coefficient and the product of the floor temper-

ature around the human body detected by the human body sensor 170 and a weighting coefficient. The weighting coefficient used to calculate the cooling reference temperature is determined in advance separately from the weighting coefficient used to calculate the heating reference temperature.

[0075] Similarly to the heating reference temperature, the difference between the floor temperature around the human body and the temperature of a foot of the human body may be used instead of directing using the floor temperature. When the foot of the human body is a temperature undetected site, the estimated temperature value of the foot of the human body, which is calculated by the estimated temperature calculator 182, is used.

[0076] The following describes, with reference to Fig. 8, an exemplary operational process of the heating operation of the air conditioning device 100 configured as described above. When the air conditioning device 100 starts the heating operation in response to, for example, an operation of the operation unit 190 by the user, first, at step S1, the human body sensor 170 starts surface temperature detection, and the human body identify part 181 starts human body detection based on a result of the detection by the human body sensor 170. At the subsequent step S2, the human body identify part 181 checks whether a human body has been detected based on the result of the detection by the human body sensor 170. When no human body has been detected, the process returns to step S1. When the human body identify part 181 has detected a human body, the process proceeds to step S3.

[0077] At step S3, first, the human body identify part 181 identifies each region in which a site of the detected human body exists. Then, the human body identify part 181 acquires the temperature of each site of the human body existing in the identified region based on the result of the detection by the human body sensor 170.

[0078] At the subsequent step S4, the estimated temperature calculator 182 checks whether the temperature of a foot of the human body (foot temperature) identified by the human body identify part 181 can be detected by the human body sensor 170. When the foot temperature of the human body cannot be detected by the human body sensor 170, the foot of the human body is identified as a "temperature undetected site". In such a case, the process proceeds to step S5.

[0079] At step S5, the estimated temperature calculator 182 acquires the floor temperature around a region in which the foot of the human body exists based on the result of the detection by the human body sensor 170. At the subsequent step S6, the estimated temperature calculator 182 calculates the estimated temperature value of the foot as a temperature undetected site of the human body based on the floor temperature acquired at step S5. After step S6, the process proceeds to step S7. When the temperature of the foot of the human body can be detected by the human body sensor 170 at step S4, the process proceeds from step S4 to step S7 without

going through steps S5 and S6.

[0080] At step S7, the air blow control unit 183 checks whether the temperature of each site of the human body identified by the human body identify part 181 is lower than the heating reference temperature. Before the check, the air blow control unit 183 calculates the heating reference temperature based on the temperature of each site of the human body acquired at step S3 and the floor temperature acquired at step S5. In this case, when step S6 has been executed to calculate the estimated value of the foot temperature of the human body, the estimated value of the foot temperature of the human body is additionally used to calculate the heating reference temperature.

[0081] Then, the air blow control unit 183 checks whether the temperature of each site of the human body acquired at step S3 is lower than the heating reference temperature. When step S6 has been executed to calculate the estimated value of the foot temperature of the human body, the air blow control unit 183 also checks whether the estimated value of the foot temperature of the human body is lower than the heating reference temperature. Then, when the temperature of each site of the human body including the estimated value is lower than the heating reference temperature, the process proceeds to step S8.

[0082] At step S8, the air blow control unit 183 controls the air blow mechanism to blow conditioned air toward the position of the human body detected by the human body sensor 170. The conditioned air here is warm air. After step S8, the process returns to step S1 and repeats the above-described steps. Thus, the blowing of conditioned air toward the position of the human body is continued as long as the temperature of each site of the human body including the estimated value is lower than the heating reference temperature at step S7. Then, when the temperature of each site of the human body including the estimated value becomes equal to or higher than the heating reference temperature at step S7, the process proceeds to step S9.

[0083] At step S9, the air blow control unit 183 performs what is called "human-avoiding air blow". Specifically, the air blow mechanism is controlled to blow conditioned air in a direction away from the position of the human body detected by the human body sensor 170. This ends the serial operational process flows, but the above-described steps S1 to S9 are repeatedly executed until the heating operation of the air conditioning device 100 is stopped.

[0084] The operational process of the cooling operation is substantially same as that of the heating operation described above. Specifically, steps S1 to S6, S8, and S9 in the case of the heating operation illustrated in Fig. 8 are same for a case in which the air conditioning device 100 starts the cooling operation in response to, for example, an operation of the operation unit 190 by the user.

[0085] Then, in the case of the cooling operation, only step S7 is different from that of the heating operation.

Specifically, at step S7 of the cooling operation, the air blow control unit 183 checks whether the temperature of each site of a human body identified by the human body identify part 181 is lower than the cooling reference temperature. Before the check, the air blow control unit 183 calculates the cooling reference temperature based on the temperature of each site of the human body acquired at step S3 and the floor temperature acquired at step S5. In this case, when step S6 has been executed to calculate the estimated value of the foot temperature of the human body, the estimated value of the foot temperature of the human body is additionally used to calculate the cooling reference temperature.

[0086] Then, the air blow control unit 183 checks whether the temperature of each site of the human body acquired at step S3 is equal to or higher than the cooling reference temperature. When step S6 has been executed to calculate the estimated value of the foot temperature of the human body, the air blow control unit 183 also checks whether the estimated value of the foot temperature of the human body is equal to or higher than the cooling reference temperature. Then, when the temperature of each site of the human body including the estimated value is equal to or higher than the cooling reference temperature, the process proceeds to step S8. When the temperature of each site of the human body including the estimated value is lower than the cooling reference temperature, the process proceeds to step S9.

[0087] Fig. 9 illustrates an exemplary adjusted R-squared value of the warm-cold feeling calculation formula used in the heating operation of the air conditioning device 100. The adjusted R-squared value is a determination coefficient provided with freedom adjustment. As illustrated in Fig. 9, when the warm-cold feeling calculation formula has, as an explanatory variable, only the temperature of the upper body detected by the human body sensor 170 but not the estimated foot temperature value calculated by the estimated temperature calculator 182, the adjusted R-squared value is 0.59. However, when the warm-cold feeling calculation formula has, as explanatory variables, the estimated foot temperature value calculated by the estimated temperature calculator 182 in addition to the temperature of the upper body detected by the human body sensor 170, the adjusted R-squared value is 0.65, which indicates improvement of the degree of fitting of the warm-cold feeling calculation formula.

[0088] When the surface temperature of a human body cannot be detected at a site by the human body sensor 170 due to an obstacle such as furniture, the air conditioning device 100 configured as described above calculates the estimated temperature value of the site and controls the air blow mechanism by using the estimated temperature value of the site. Thus, conditioned air can be appropriately blown to the human body of the user irrespective of the existence of an obstacle such as furniture, which leads to an improved comfortable feeling of the user.

[0089] The following describes a modification of the air conditioning device 100 according to Embodiment 1 of the present invention described above. In the modification, when a human body has a temperature undetected site at a foot or a hand, the estimated temperature calculator 182 uses the floor temperature as the estimated temperature value of the temperature undetected site. The air blow control unit 183 uses the temperature of air sucked through the air intake port 111 as the heating reference temperature. The temperature of air sucked through the air intake port 111 is the temperature of air in the room in which the air conditioning device 100 is installed, in other words, the indoor temperature. Thus, in the modification, the air conditioning device 100 includes a temperature sensor configured to detect the temperature of air sucked through the air intake port 111 or the indoor temperature.

[0090] As described above, when the estimated temperature value of a site of a human body, which is calculated by the estimated temperature calculator 182 in the heating operation, is lower than the heating reference temperature, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points to the position of the human body. Thus, in the modification, when the floor temperature is lower than the temperature of air sucked through the air intake port 111 in the heating operation, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points to the position of the human body.

[0091] Specifically, in the modification as described above, when the temperature of a foot or hand of a human body is not detected by the human body sensor 170 as the temperature sensor and the floor temperature detected by the human body sensor 170 as the floor temperature sensor is lower than the temperature of air sucked through the air intake port 111, the air blow control unit 183 controls the air blow mechanism so that the direction of conditioned air points to the position of the human body.

[0092] In this manner, it is possible to easily calculate and set the estimated temperature value of a temperature undetected site and the heating reference temperature, perform air blow control with taken into account the surface temperature of the human body of a user with a reduced processing load when there is an obstacle such as furniture, and appropriately blow conditioned air to the human body of the user, which leads to an improved comfortable feeling of the user.

[0093] The inventor has confirmed through a heating experiment that, when the floor temperature around a person becomes equal to or higher than the set temperature of the air conditioning device 100, the warm-cold feeling of the person becomes equal to or higher than neutral, in other words, the person tends to have a neutral warm-cold feeling or feel slightly hot. When the warm-cold feeling calculation formula has, as an explanatory variable, the floor temperature detected by the human body sensor 170 as the floor temperature sensor, the

adjusted R-squared value is 0.58. This is equivalent to the adjusted R-squared value of 0.59 when the warm-cold feeling calculation formula has, as an explanatory variable, only the temperature of the upper body detected by the human body sensor 170. This indicates that, in the modification, too, the degree of fitting of the warm-cold feeling calculation formula is sufficient.

Embodiment 2

[0094] Figs. 10 and 11 relate to Embodiment 2 of the present invention. Fig. 10 is a flowchart of air blow control of the air conditioning device in the heating operation. Fig. 11 is a diagram illustrating an exemplary adjusted R-squared value of the warm-cold feeling calculation formula used in the heating operation of the air conditioning device.

[0095] In Embodiment 2 described below, the duration in which the temperature of a region in which a temperature undetected site of a human body exists is detected by the human body sensor 170 is additionally used to calculate the estimated temperature value of the site in the configuration of Embodiment 1 described above. The following describes the air conditioning device according to Embodiment 2 with focus on difference from Embodiment 1.

[0096] Similarly to Embodiment 1, the control device 180 of the air conditioning device 100 according to Embodiment 2 includes the human body identify part 181, the estimated temperature calculator 182, and the air blow control unit 183 as illustrated in Fig. 7. The estimated temperature calculator 182 of the air conditioning device 100 according to Embodiment 2 calculates the estimated temperature value of a temperature undetected site based on the duration in which the temperature of the human body is detected by the temperature sensor in addition to a result of the detection by the temperature sensor and a result of the detection by the floor temperature sensor.

[0097] In this example, similarly to Embodiment 1, the human body sensor 170 also serves as the temperature sensor and the floor temperature sensor. Thus, in the example described in Embodiment 2, the estimated temperature calculator 182 calculates the estimated temperature value of a temperature undetected site based on the result of the detection by the human body sensor 170 and the duration in which the temperature of the human body is detected by the human body sensor 170.

[0098] For example, the estimated temperature calculator 182 calculates the estimated temperature value of a temperature undetected site of a human body based on the floor temperature around the human body, the temperature of the site of the human body, the temperature of which is detected by the human body sensor 170, and the duration in which the temperature of the human body is detected by the human body sensor 170. For this calculation, the memory of the control device 180 stores therein in advance a relational expression that cal-

culates the temperature of an optional site of a human body based on the floor temperature around the human body, the temperature of a site such as the head of the human body, the skin temperature of which is likely to be detected, and the stay time of the human body in the room.

[0099] Then, the estimated temperature calculator 182 calculates the estimated temperature value of a temperature undetected site of a human body by using the relational expression based on the detected floor temperature, the detected temperature of a human body, and the stay time of the human body in the room. The stay time of the human body in the room can be calculated based on the duration in which the temperature of the human body is detected by the human body sensor 170.

[0100] The other configuration is same as that of Embodiment 1, and thus detailed description thereof will be omitted.

[0101] The following describes, with reference to Fig. 10, an exemplary operational flow of the heating operation of the air conditioning device 100 configured as described above. In the flowchart illustrated in Fig. 10, steps S11 to S14 are same as steps S1 to S4 in Fig. 8, and thus description thereof will be omitted.

[0102] At step S15, the estimated temperature calculator 182 acquires an elapsed time since the human body sensor 170 starts detection of the temperature of a human body, and sets the elapsed time to be the stay time of the human body in the room. After step S15, the process proceeds to step S16. Step S16 in Fig. 10 is same as step S5 in Fig. 8.

[0103] At step S17, the estimated temperature calculator 182 calculates the estimated temperature value of a foot as a temperature undetected site of the human body based on the stay time acquired at step S15 and the floor temperature acquired at step S16. After step S17, the process proceeds to step S18. Steps S18 to S20 in Fig. 10 are same as steps S7 to S9 in Fig. 8, and thus description thereof will be omitted.

[0104] The above description is made on the operational process of the heating operation, but the operational process of the cooling operation is substantially same. Specifically, steps S11 to S17, S19, and S20 in the case of the heating operation illustrated in Fig. 10 are same for a case in which the air conditioning device 100 starts the cooling operation in response to, for example, an operation of the operation unit 190 by a user.

[0105] In the case of the cooling operation, only step S18 is different from that in the heating operation. Specifically, at step S18 in the cooling operation, the air blow control unit 183 checks whether the temperature of each site of the human body identified by the human body identify part 181 is lower than the cooling reference temperature. Before the check, the air blow control unit 183 calculates the cooling reference temperature based on the temperature of each site of the human body acquired at step S13 and the floor temperature acquired at step S15. In this case, when step S17 has been executed to cal-

culate the estimated value of the foot temperature of the human body, the estimated value of the foot temperature of the human body is additionally used to calculate the cooling reference temperature.

[0106] Then, the air blow control unit 183 checks whether the temperature of each site of the human body acquired at step S13 is equal to or higher than the cooling reference temperature. When step S17 has been executed to calculate the estimated value of the foot temperature of the human body, the air blow control unit 183 also checks whether the estimated value of the foot temperature of the human body is equal to or higher than the cooling reference temperature. Then, when the temperature of each site of the human body including the estimated value is equal to or higher than the cooling reference temperature, the process proceeds to step S19. When the temperature of each site of the human body including the estimated value is lower than the cooling reference temperature, the process proceeds to step S20.

[0107] Fig. 11 illustrates an exemplary adjusted R-squared value (determination coefficient provided with freedom adjustment) of the warm-cold feeling calculation formula used in the heating operation of the air conditioning device 100. As illustrated in Fig. 11, the adjusted R-squared value is 0.59 when the warm-cold feeling calculation formula has, as an explanatory variable, only the temperature of the upper body detected by the human body sensor 170 but not the estimated foot temperature value calculated by the estimated temperature calculator 182.

[0108] However, the adjusted R-squared value is 0.62 when the warm-cold feeling calculation formula has, as explanatory variables, the estimated temperature value of a foot leading end part calculated by the estimated temperature calculator 182 in addition to the temperature of the upper body detected by the human body sensor 170. The adjusted R-squared value is 0.61 when the warm-cold feeling calculation formula has, as explanatory variables, the estimated temperature value of the top of a foot calculated by the estimated temperature calculator 182 in addition to the temperature of the upper body detected by the human body sensor 170.

[0109] In this manner, appropriate temperature estimated values can be calculated for small divided sites of a foot, such as the leading end part and the top, which indicates improvement of the degree of fitting of the warm-cold feeling calculation formula.

[0110] The air conditioning device configured as described above can achieve, in addition to effects similar to those of Embodiment 1, improved accuracy for the temperature estimated value of a site of a human body by calculating the temperature estimated value of the site of the human body with taken into account the stay time of the human body in a room, and can further achieve appropriate air blow control. In particular, when a plurality of persons, the stay times of which are different are in a room, conditioned air can be appropriately blown to each

person.

Embodiment 3

[0111] Fig. 12 relates to Embodiment 3 of the present invention, and is a flowchart of air blow control of the air conditioning device in the heating operation.

[0112] The following describes the air conditioning device according to Embodiment 3 with focus on difference from Embodiment 1 or 2. In Embodiment 3 described below, the human body sensor 170 is installed at a position different from that of the housing 110 of the air conditioning device 100 in the configuration of Embodiment 1 or 2 described above. Specifically, the human body sensor 170 is installed on, for example, a wall or ceiling of a room, the remote controller of the air conditioning device 100, or a portable information terminal such as a smartphone.

[0113] Alternatively, the human body sensor 170 may be provided to a human body mounting unit attachable to a human body. The human body mounting unit includes, for example, an extendable band, and can be mounted on, for example, a wrist or ankle of the human body. When the human body sensor 170 is installed at a position different from that of the housing 110 of the air conditioning device 100, the human body sensor 170 and the control device 180 provided to the housing 110 are configured to perform bidirectional communication therebetween.

[0114] The other configuration is same as that of Embodiment 1 or 2, and thus detailed description thereof will be omitted.

[0115] The following describes, with reference to Fig. 12, an exemplary operational flow of the heating operation of the air conditioning device 100 configured as described above. In the flowchart illustrated in Fig. 12, steps S21 to S24 are same as steps S1 to S4 in Fig. 8, and thus description thereof will be omitted.

[0116] At step S25, the temperature of a foot of a human body is directly measured by the human body sensor 170 provided to the human body mounting unit mounted on the human body. After step S25, the process proceeds to step S26.

[0117] At step S26, the air blow control unit 183 checks whether the temperature of each site of the human body identified by the human body identify part 181 is lower than the heating reference temperature. Before the check, the air blow control unit 183 calculates the heating reference temperature based on the temperature of each site of the human body acquired at step S23 and the foot temperature acquired at step S25.

[0118] Then, the air blow control unit 183 checks whether the temperature of each site of the human body acquired at step S23 is lower than the heating reference temperature. When step S25 has been executed to directly measure the foot temperature of the human body, the air blow control unit 183 also checks whether the measured value of the foot temperature of the human

body is lower than the heating reference temperature. When the temperature of each site of the human body including the measured value is lower than the heating reference temperature, the process proceeds to step S27. When the temperature of each site of the human body including the measured value is equal to or higher than the heating reference temperature, the process proceeds to step S28.

[0119] Steps S27 and S28 in Fig. 12 are same as steps S8 and S9 in Fig. 8, and thus description thereof will be omitted.

[0120] The above description is made on the operational process of the heating operation, but the operational process of the cooling operation can be performed in a manner similar to that in Embodiment 1 or 2.

[0121] The air conditioning device configured as described above can achieve effects similar to those of Embodiment 1 or 2, and can directly measure the temperature of a site of a human body, the temperature of which cannot be detected only by the human body sensor 170 installed in the housing 110 of the air conditioning device 100, and appropriately blow conditioned air to the human body of a user, which leads to a further improved comfortable feeling of the user.

Embodiment 4

[0122] Fig. 13 relates to Embodiment 4 of the present invention, and is a flowchart of air blow control of the air conditioning device in the heating operation.

[0123] In Embodiment 4 described below, the human body sensor 170 is provided with a camera configured to capture an image of, for example, the face of a human body in the configuration of any of Embodiments 1 to 3 described above. Personal authentication is performed based on the image of, for example, the face captured by the camera to perform air blow control appropriate for a person. The following describes the air conditioning device according to Embodiment 4 with focus on difference from Embodiments 1 to 3.

[0124] Specifically, the human body sensor 170 of the air conditioning device 100 according to Embodiment 4 includes a camera configured to capture an image of a human body. The human body identify part 181 of the control device 180 performs personal authentication of the human body based on the image of the human body captured by the camera. The personal authentication can be performed by extracting feature points from an image of, for example, the face of the human body, and performing matching or the like with feature points of each person stored in the memory of the control device 180 in advance.

[0125] The estimated temperature calculator 182 can set parameters (such as weighting coefficients) different between authenticated persons to a calculation formula for the estimated temperature value of a temperature undetected site. The air blow control unit 183 can set parameters different between authenticated persons to a

calculation formula for the heating reference temperature or the cooling reference temperature. In addition, a parameter such as the air volume can be set different between authenticated persons in control of the air blow mechanism by the air blow control unit 183.

[0126] The other configuration is same as any of those of Embodiments 1 to 3, and thus detailed description thereof will be omitted.

[0127] The following describes, with reference to Fig. 13, an exemplary operational flow of the heating operation of the air conditioning device 100 configured as described above. In the flowchart illustrated in Fig. 13, steps S31 to S36 are same as steps S1 to S6 in Fig. 8, and thus description thereof will be omitted.

[0128] At step S37, the human body identify part 181 performs personal authentication of the human body based on image data obtained through image capturing by the camera included in the human body sensor 170, and identifies the person of the human body. After step S37, the process proceeds to step S38.

[0129] Steps S38 to S40 in Fig. 13 are same as steps S7 to S9 in Fig. 8, and thus description thereof will be omitted.

[0130] The above description is made on the operational process of the heating operation, but the operational process of the cooling operation can be performed in a manner similar to those in Embodiments 1 to 3.

[0131] The air conditioning device configured as described above can achieve effects similar to those of Embodiment 1, 2, or 3, and can set air blow control parameters different between persons identified through personal authentication and achieve, for example, air blow control reflecting the warm-cold feeling difference between the persons, which leads to a further improved comfortable feeling of a user.

[0132] In the configurations of Embodiments 1 to 4 described above, one or both of air blow control in the heating operation and air blow control in the cooling operation may be employed. Moreover, air blow control in the heating operation and air blow control in the cooling operation in embodiments different from each other may be employed in combination.

[0133] When air is blown toward a human body, the air may be blown toward a particular site of the human body, not toward the entire human body. Specifically, for example, the air may be blown toward the feet of the human body in a focused manner. In the configuration of Embodiment 4, which can identify a person, a particular site of the human body to which air is blown may be different between persons.

[0134] In addition, air blow control may be performed by using temperature information such as the room temperature, the temperature at the air intake port 111 of the air conditioning device, and the temperature at the air outlet port 112 in addition to the floor temperature and the skin temperature. In this case, for example, the change amount or change rate of the temperature information per constant time may be used.

Industrial Applicability

[0135] The present invention is applicable to an air conditioning device including an air blow mechanism capable of changing the direction of conditioned air blown out through an air outlet port.

Reference Signs List

- [0136] 100 Conditioning device
- 110 Housing
- 111 Air intake port
- 112 Air outlet port
- 113 Front surface panel
- 121 Heat exchanger
- 122 Air blow fan
- 131 Front-left side vertical deflector
- 132 Front-right side vertical deflector
- 141 Back-left side vertical deflector
- 142 Back-right side vertical deflector
- 150 Right-left deflector
- 161 Left side vertical deflector stepping motor
- 162 Right side vertical deflector stepping motor
- 163 Right-left deflector stepping motor
- 170 Human body sensor
- 171 Cylindrical metal can
- 172 Sensor stepping motor
- 173 Distributive view angle
- 180 Control device
- 181 Human body identify part
- 182 Estimated temperature calculator
- 183 Air blow control unit
- 190 Operation unit

Claims

- 1. An air conditioning device comprising:
 - a housing having an air intake port and an air outlet port;
 - a heat exchanger arranged in the housing, the heat exchanger configured to exchange heat with air sucked from the air intake port to generate conditioned air;
 - an air blow mechanism provided to the housing, the air blow mechanism configured to generate air flow which sucks air from the air intake port and blows out the conditioned air from the air outlet port, and capable of changing a direction of the conditioned air which blows from the air outlet port;
 - a temperature sensor configured to detect surface temperature in a predetermined detection range;
 - a human body identify part configured to detect

a human body and to identify a region in which the detected human body exists based on a detection result of the temperature sensor;

a floor temperature sensor configured to detect floor temperature;

an estimated temperature calculator configured to identify a site in which temperature of the human body is not detected by the temperature sensor in the region in which the human body exists, and to calculate an estimated value of temperature of the identified site of the human body based on the detection result of the temperature sensor and a detection result of the floor temperature sensor;

an air blow control unit configured to control the air blow mechanism based on the estimated value of temperature of the site of the human body.

- 2. The air conditioning device according to claim 1, wherein the air blow control unit:

controls the air blow mechanism so that the direction of the conditioned air points to the position of the human body when the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator, is lower than a heating reference temperature in a heating operation; and

controls the air blow mechanism so that the direction of the conditioned air points in a direction away from the position of the human body when the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator, is higher than the heating reference temperature in the heating operation.

- 3. The air conditioning device according to claim 1, wherein the air blow control unit:

controls the air blow mechanism so that the direction of the conditioned air points to the position of the human body when the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator, is higher than a cooling reference temperature in cooling operation; and

controls the air blow mechanism so that the direction of the conditioned air points in a direction away from the position of the human body when the estimated temperature value of the site of the human body, which is calculated by the estimated temperature calculator, is lower than the cooling reference temperature in the cooling operation.

- 4. The air conditioning device according to any one of claims 1 to 3, wherein the human body identify part

individually identifies the region in which the human body exists for each site of the human body.

5. The air conditioning device according to claim 4, wherein the human body identify part identifies a part in which the surface temperature detected by the temperature sensor is equal to or higher than a pre-determined temperature as a region in which at least one of the head, chest, and abdomen of the human body exists.

6. The air conditioning device according to claim 4 or 5, wherein the estimated temperature calculator identifies a region in which one or both of a foot and a lower leg of the human body identified by the human body identify part exist, as the site in which the temperature of the human body is not detected by the temperature sensor.

7. The air conditioning device according to any one of claims 1 to 6, wherein the estimated temperature calculator calculates an estimated temperature value of the site of the human body in which the temperature of the human body is not detected by the temperature sensor, additionally based on a duration in which the temperature of the human body is detected by the temperature sensor.

8. The air conditioning device according to any one of claims 1 to 7, wherein the air blow mechanism includes:

- an air blow fan configured to generate airflow passing through the heat exchanger;
- a vertical wind direction control plate configured to vertically adjust the direction of the conditioned air blown out through the air outlet port;
- a horizontal wind direction control plate configured to horizontally adjust the direction of the conditioned air blown out through the air outlet port;
- a first stepping motor configured to drive the vertical wind direction control plate; and
- a second stepping motor configured to drive the horizontal wind direction control plate.

9. The air conditioning device according to claim 2 or 3, wherein, when controlling the air blow mechanism so that the direction of the conditioned air points in a direction away from the position of the human body, the air blow control unit controls the air blow mechanism so that the distance between the human body and airflow of the conditioned air is equal to or larger than 0.3 m.

10. The air conditioning device according to any one of claims 1 to 9, wherein the temperature sensor includes an infrared sensor.

11. The air conditioning device according to any one of claims 1 to 10, further comprising an ultrasonic wave sensor capable of detecting an object, wherein the human body identify part detects the human body based on a result of the detection by the temperature sensor and a result of the detection by the ultrasonic wave sensor, and identifies the region in which the detected human body exists.

12. The air conditioning device according to any one of claims 1 to 11, wherein the temperature sensor is provided to the human body mounting unit attachable to the human body.

13. The air conditioning device according to any one of claims 1 to 12, wherein the temperature sensor also serves as the floor temperature sensor.

14. An air conditioning device comprising:

- a housing having an air intake port and an air outlet port;
- a heat exchanger arranged in the housing, the heat exchanger configured to exchange heat with air sucked through the air intake port to generate conditioned air;
- an air blow mechanism provided to the housing, the air blow mechanism configured to generate air flow which sucks air from the air intake port and blows out the conditioned air from the air outlet port, and capable of changing the direction of the conditioned air blown out from the air outlet port;
- a temperature sensor configured to detect surface temperature in a predetermined detection range;
- a floor temperature sensor configured to detect floor temperature; and
- an air blow control unit configured to control, when the temperature in a site of a foot or a hand of a human body is not detected by the temperature sensor and the floor temperature is lower than the temperature of air sucked through the air intake port, the air blow mechanism so that the direction of conditioned air points to the position of the human body.

FIG. 1

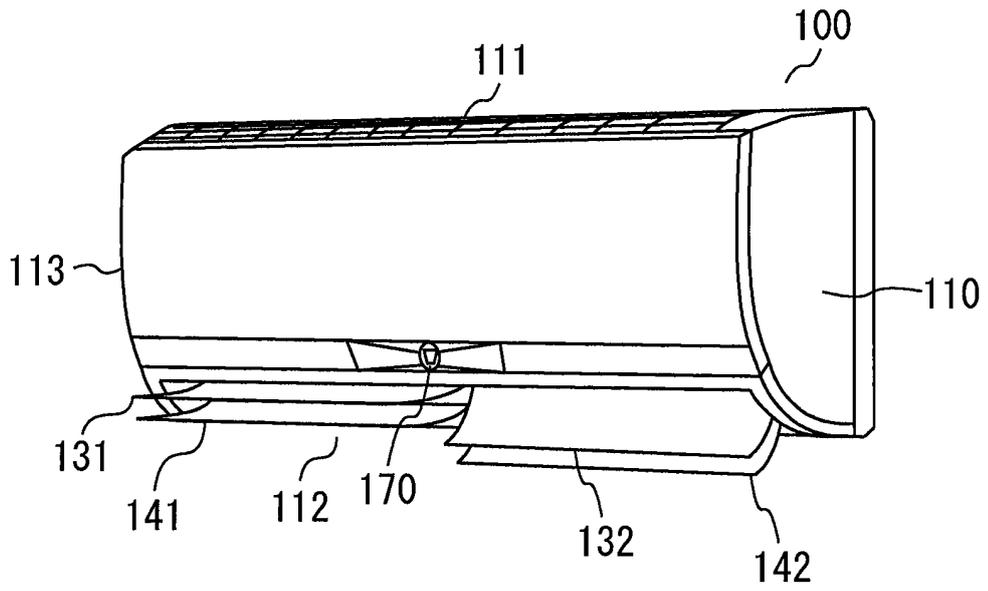


FIG. 2

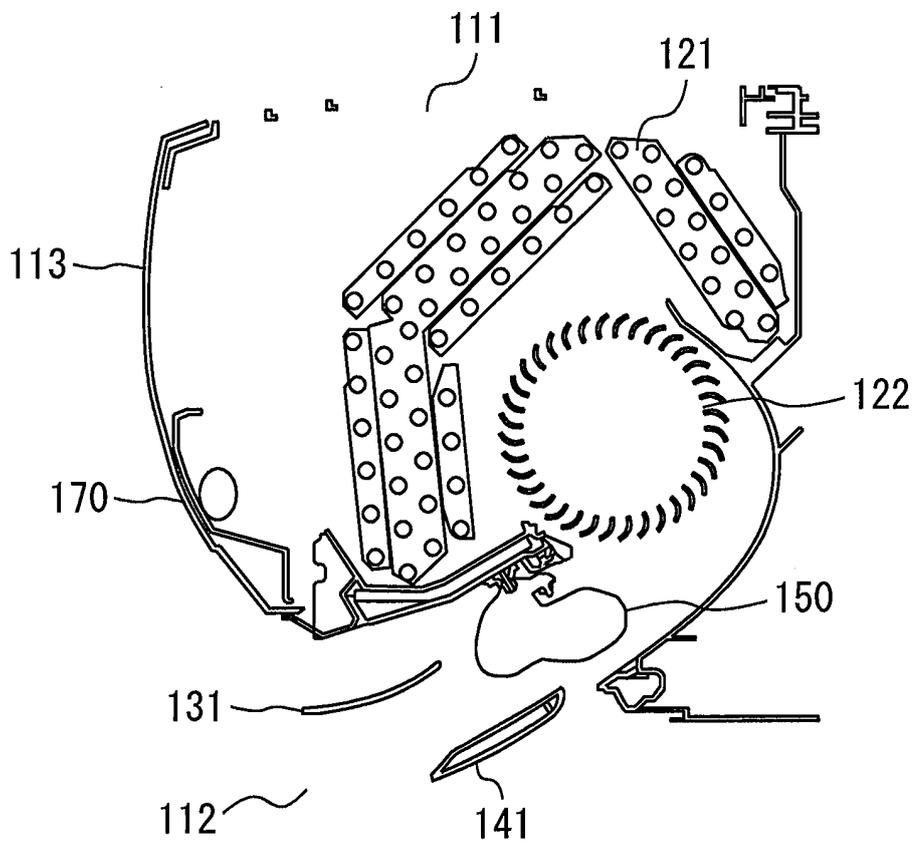


FIG. 3

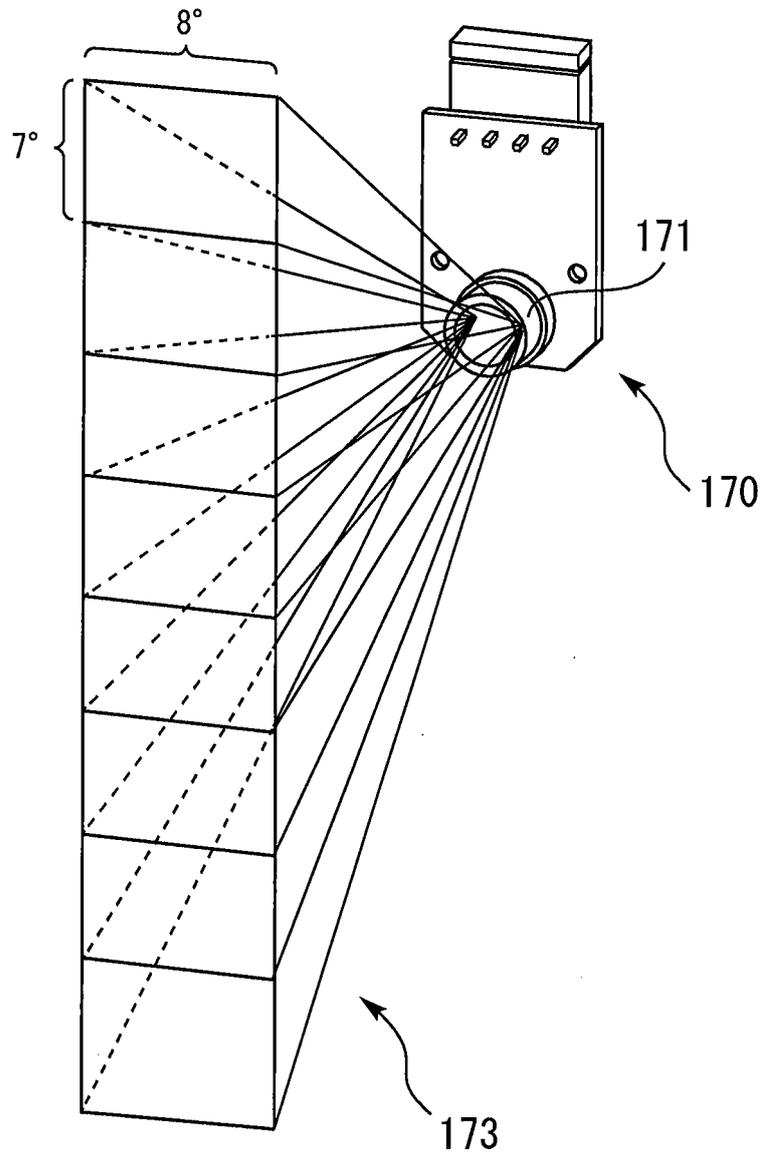


FIG. 4

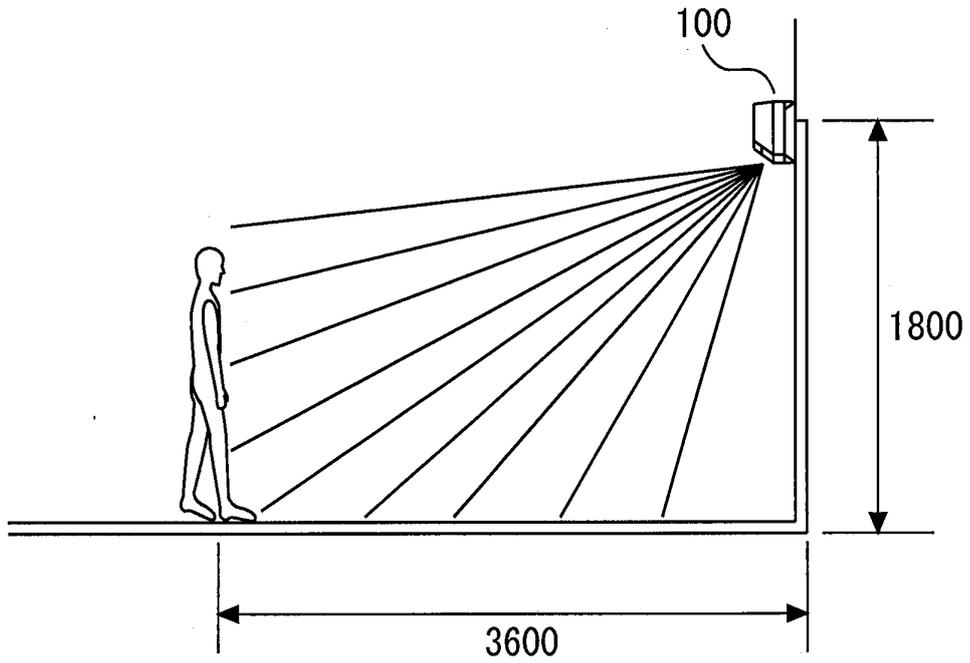


FIG. 5

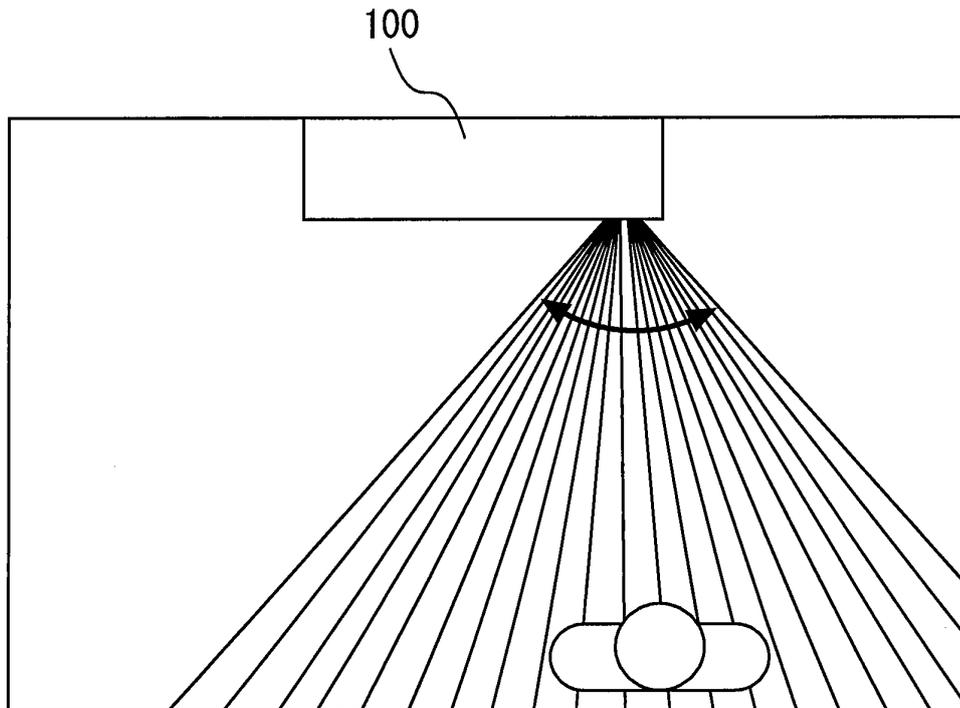
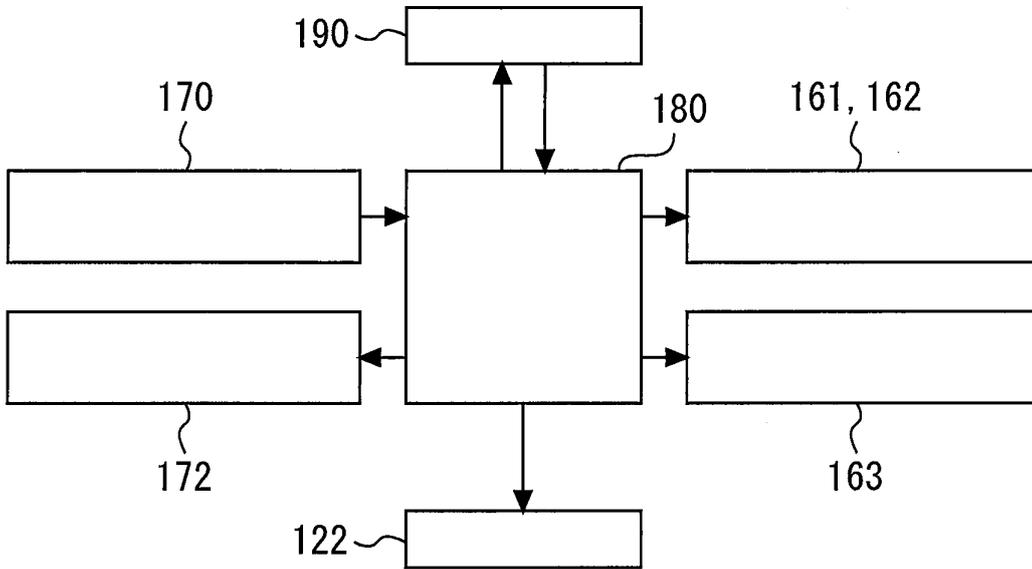
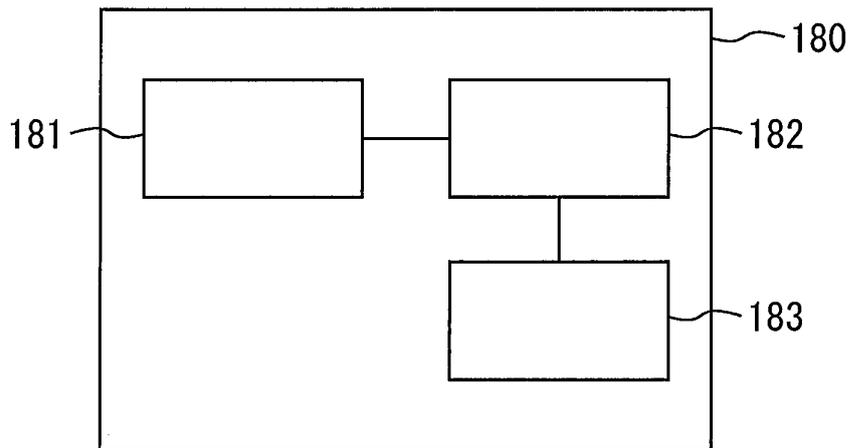


FIG. 6



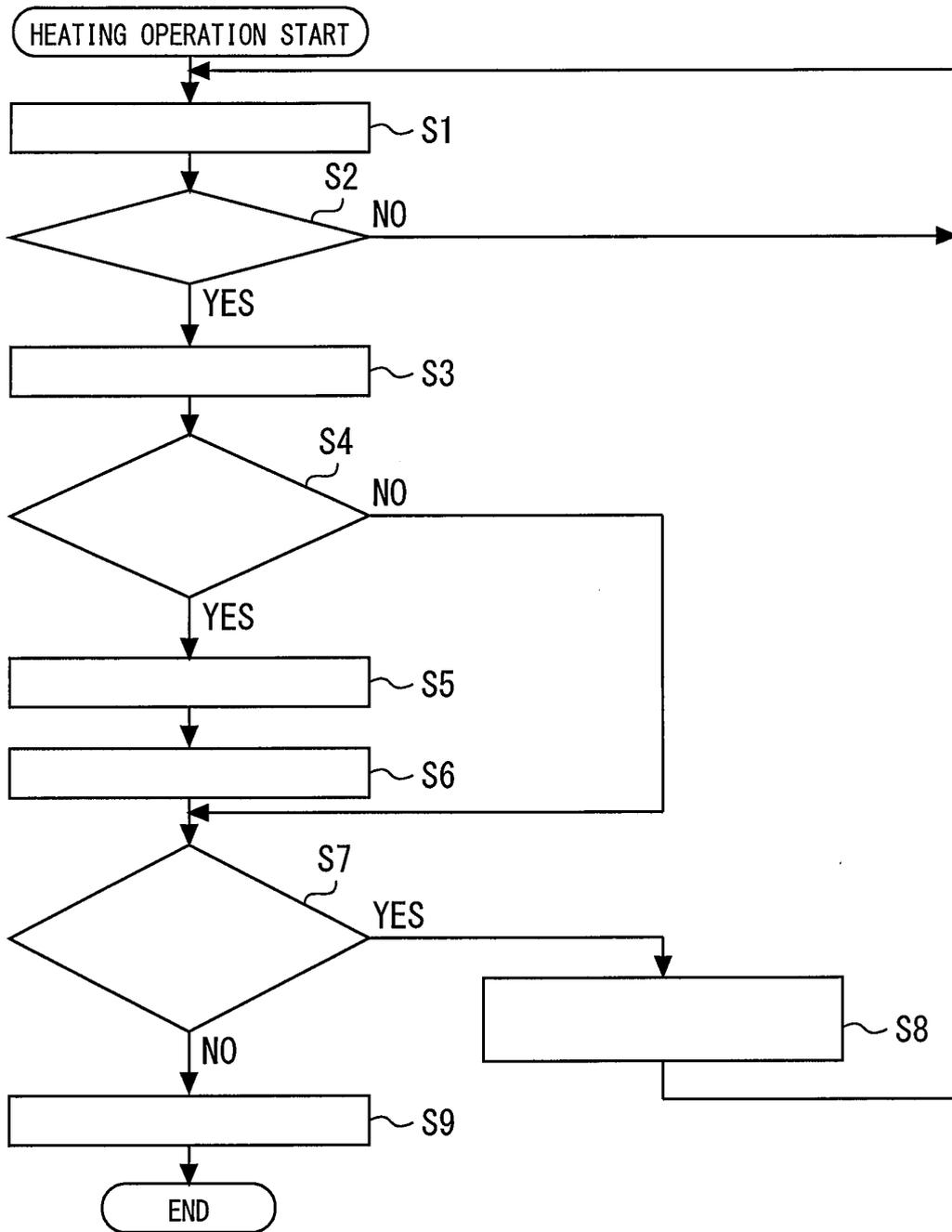
- 122: AIR BLOW FAN
- 161, 162: VERTICAL DEFLECTOR STEPPING MOTOR
- 163: RIGHT-LEFT DEFLECTOR STEPPING MOTOR
- 170: HUMAN BODY SENSOR
- 172: SENSOR STEPPING MOTOR
- 180: CONTROL DEVICE
- 190: OPERATION UNIT

FIG. 7



- 180: CONTROL DEVICE
- 181: HUMAN BODY IDENTIFY PART
- 182: ESTIMATED TEMPERATURE CALCULATOR
- 183: AIR BLOW CONTROL UNIT

FIG. 8

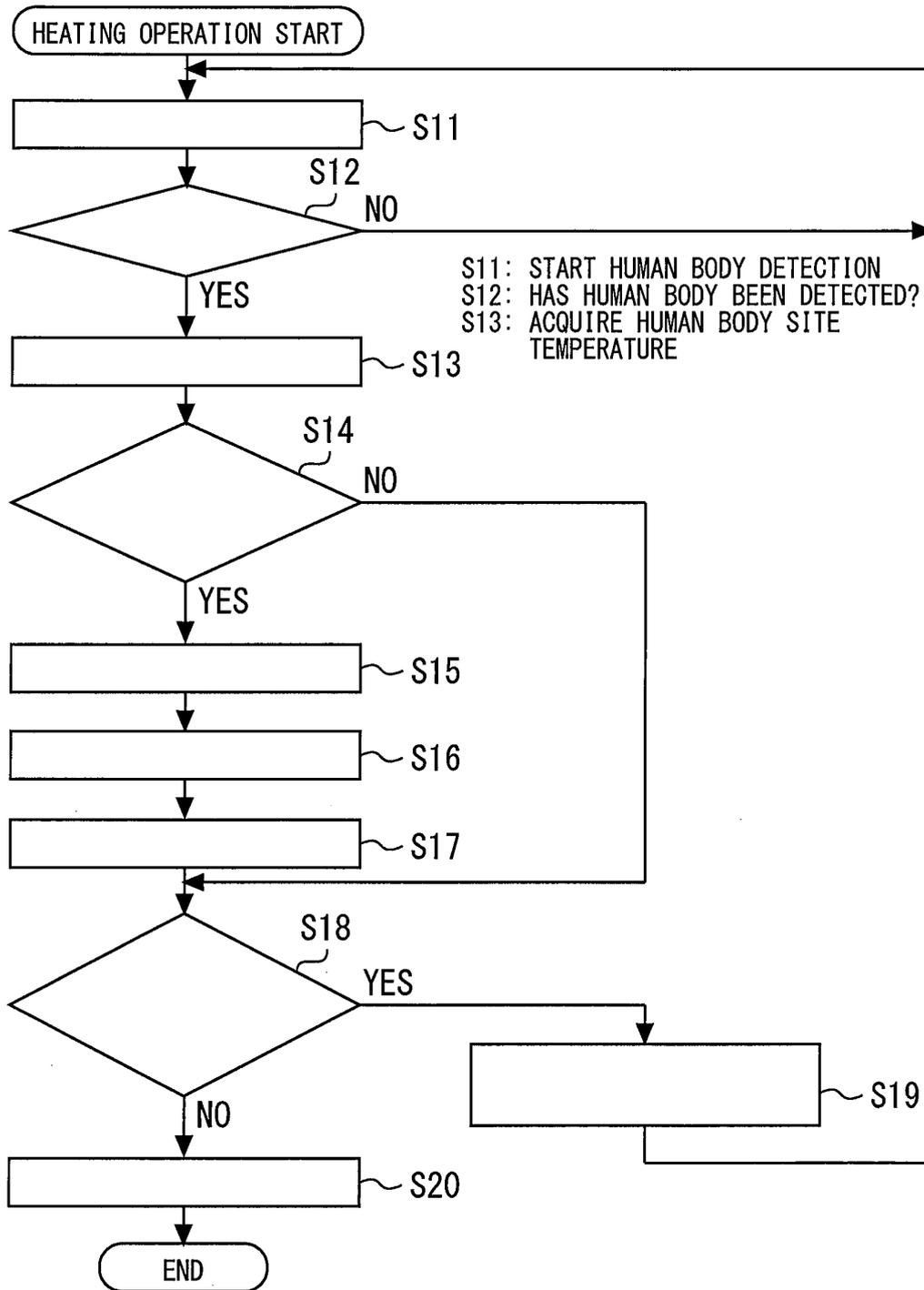


- S1: START HUMAN BODY DETECTION
- S2: HAS HUMAN BODY BEEN DETECTED?
- S3: ACQUIRE HUMAN BODY SITE TEMPERATURE
- S4: CAN NO FOOT TEMPERATURE BE DETECTED?
- S5: ACQUIRE FLOOR TEMPERATURE
- S6: CALCULATE ESTIMATED FOOT TEMPERATURE
- S7: IS HUMAN BODY SITE TEMPERATURE LOWER THAN HEATING REFERENCE TEMPERATURE?
- S8: BLOW AIR TOWARD HUMAN BODY
- S9: PERFORM HUMAN-AVOIDING AIR BLOW

FIG. 9

EXPLANATORY VARIABLE	ADJUSTED R-SQUARED VALUE
UPPER BODY (EXCEPT FOR HAND)	0.59
UPPER BODY (EXCEPT FOR HAND) + CALCULATED VALUE OF FOOT	0.65

FIG. 10



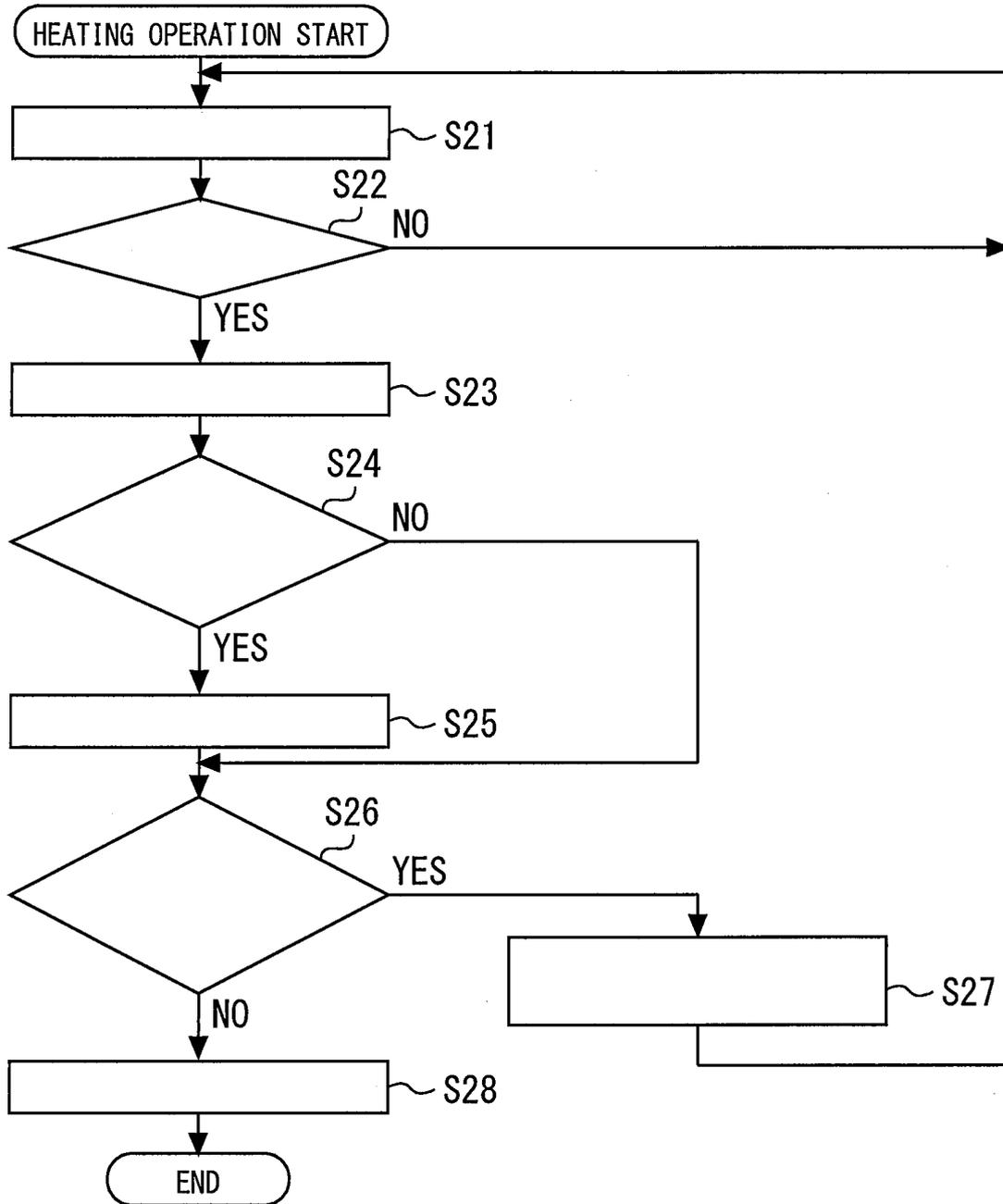
S11: START HUMAN BODY DETECTION
 S12: HAS HUMAN BODY BEEN DETECTED?
 S13: ACQUIRE HUMAN BODY SITE TEMPERATURE

S14: CAN NO FOOT TEMPERATURE BE DETECTED?
 S15: ACQUIRE STAY TIME
 S16: ACQUIRE FLOOR TEMPERATURE
 S17: CALCULATE ESTIMATED FOOT TEMPERATURE
 S18: IS HUMAN BODY SITE TEMPERATURE LOWER THAN HEATING REFERENCE TEMPERATURE?
 S19: BLOW AIR TOWARD HUMAN BODY
 S20: PERFORM HUMAN-AVOIDING AIR BLOW

FIG. 11

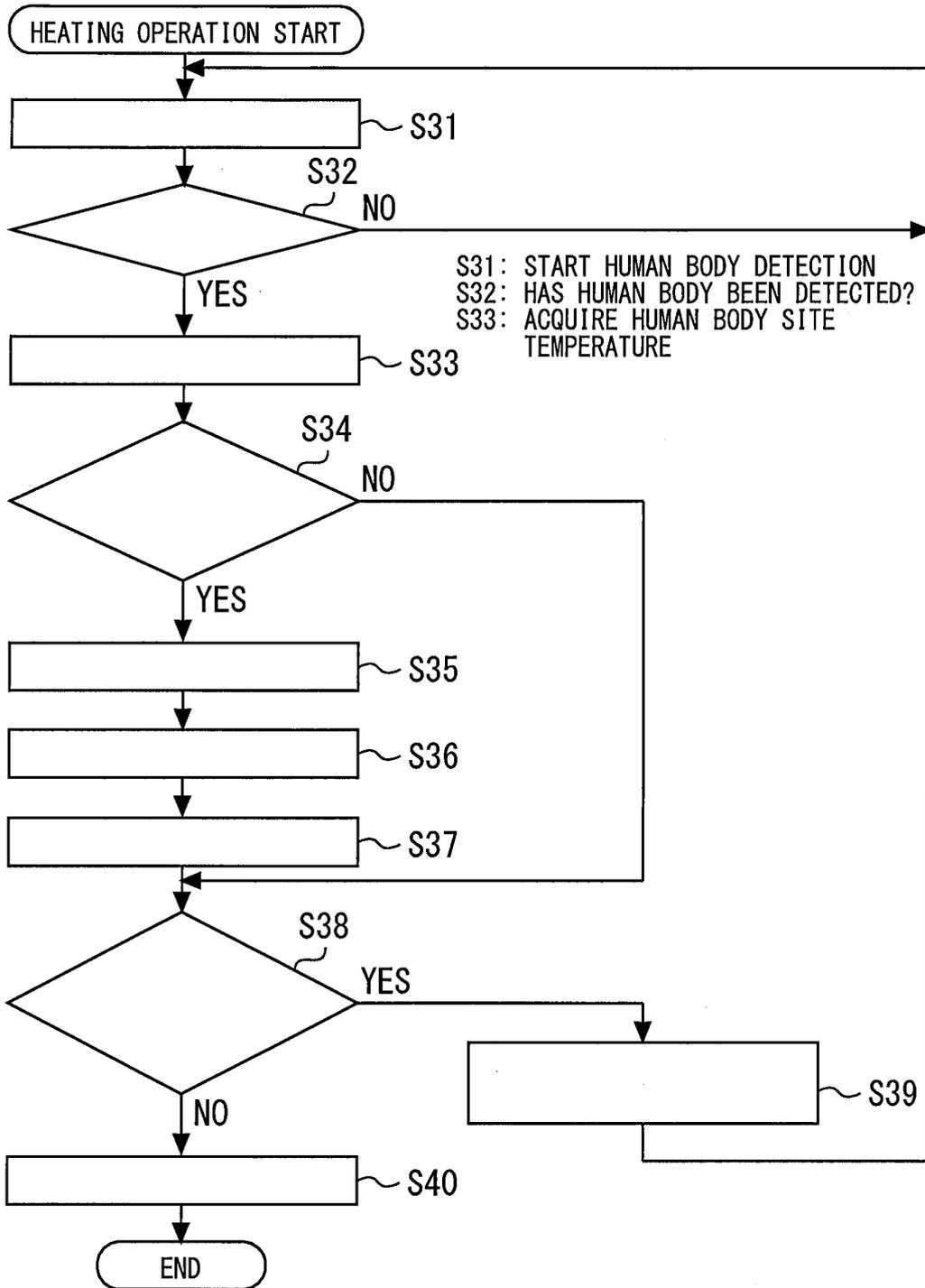
EXPLANATORY VARIABLE	ADJUSTED R-SQUARED VALUE
UPPER BODY (EXCEPT FOR HAND)	0.59
UPPER BODY (EXCEPT FOR HAND)+CALCULATED VALUE OF FOOT LEADING END PART	0.62
UPPER BODY (EXCEPT FOR HAND) + CALCULATED VALUE OF FOOT TOP	0.61

FIG. 12



- S21: START HUMAN BODY DETECTION
- S22: HAS HUMAN BODY BEEN DETECTED?
- S23: ACQUIRE HUMAN BODY SITE TEMPERATURE
- S24: CAN NO FOOT TEMPERATURE BE DETECTED?
- S25: DIRECTLY MEASURE FOOT TEMPERATURE
- S26: IS HUMAN BODY SITE TEMPERATURE LOWER THAN HEATING REFERENCE TEMPERATURE?
- S27: BLOW AIR TOWARD HUMAN BODY
- S28: PERFORM HUMAN-AVOIDING AIR BLOW

FIG. 13



S31: START HUMAN BODY DETECTION
 S32: HAS HUMAN BODY BEEN DETECTED?
 S33: ACQUIRE HUMAN BODY SITE TEMPERATURE

S34: CAN NO FOOT TEMPERATURE BE DETECTED?
 S35: ACQUIRE FLOOR TEMPERATURE
 S36: CALCULATE ESTIMATED FOOT TEMPERATURE
 S37: IDENTIFY PERSON OF HUMAN BODY
 S38: IS HUMAN BODY SITE TEMPERATURE LOWER THAN HEATING REFERENCE TEMPERATURE?
 S39: BLOW AIR TOWARD HUMAN BODY
 S40: PERFORM HUMAN-AVOIDING AIR BLOW

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/074669

5	A. CLASSIFICATION OF SUBJECT MATTER F24F11/02(2006.01) i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) F24F11/02	
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016 Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016	
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	A	WO 2015/122201 A1 (Panasonic Corp.), 20 August 2015 (20.08.2015), claims & JP 6001183 B2 & CN 105339742 A
30	A	JP 2013-44476 A (Maspro Denkoh Corp.), 04 March 2013 (04.03.2013), claims & WO 2013/027831 A1
35	A	JP 2012-154591 A (Mitsubishi Electric Corp.), 16 August 2012 (16.08.2012), claims (Family: none)
40	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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 "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
50	Date of the actual completion of the international search 07 November 2016 (07.11.16)	Date of mailing of the international search report 15 November 2016 (15.11.16)
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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

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Patent documents cited in the description

- JP H06288598 A [0003]