

DESCRIPTION

Title of Invention: REPLACEMENT AIR-CONDITIONING SYSTEM AND
INFORMATION PROCESSING METHOD

Technical Field

[0001]

The present disclosure relates to a replacement air-conditioning system and an information processing method.

Background Art

[0002]

A replacement air-conditioning system has been known as one of air-conditioning systems. A replacement air-conditioning system reduces a contaminant concentration in a residential zone of an indoor space and favorably maintains an air environment of the indoor space by sequentially replacing air having a high contaminant concentration in the residential zone with fresh air having a low contaminant concentration.

[0003]

For example, PTL 1 discloses an air-conditioning control system for a large-space building that detects a temperature at a preset temperature stratification height in a residential zone and controls the number of revolutions of a blowing fan based on a detection value.

Citation List

Patent Literature

[0004]

PTL 1: Japanese Patent No. 6414685

Summary of Invention

Technical Problem

[0005]

However, the technique described in PTL 1 detects a temperature value of the preset temperature stratification height, and does not necessarily detect information suitable for grasping a state of stratification of a temperature or an air component.

[0006]

An object of the present disclosure is to provide a replacement air-conditioning system and the like capable of detecting information suitable for grasping a state of stratification of a temperature or an air component.

Solution to Problem

[0007]

A replacement air-conditioning system according to a first aspect of the present disclosure is configured to be able to form stratification of a temperature or an air component in a room by supplying conditioned air to a lower side of the room and discharging indoor air from an upper side of the room. The system includes a detection unit that detects the temperature or the air component in the room. The detection unit detects temperatures or air components at

a first height set above an assumed boundary height of the stratification in the room and a second height set below the assumed boundary height.

[0008]

In the replacement air-conditioning system according to the first aspect, in a replacement air-conditioning system according to a second aspect of the present disclosure, the first height is set in advance as a height above a head of a person in the room.

[0009]

In the replacement air-conditioning system according to the first aspect or the second aspect, a replacement air-conditioning system according to a third aspect of the present disclosure further includes a control unit, a control unit. The control unit derives information regarding a boundary height of the stratification in the room based on the temperatures or the air components at the first height and the second height detected by the detection unit.

[0010]

In the replacement air-conditioning system according to the third aspect, in a replacement air-conditioning system according to a fourth aspect of the present disclosure, the control unit determines whether a boundary of the stratification is present between the first height and the second height based on the temperatures or the air

components at the first height and the second height.

[0011]

In the replacement air-conditioning system according to the third aspect or the fourth aspect, in a replacement air-conditioning system according to a fifth aspect of the present disclosure, the control unit determines that the boundary height of the stratification in the room is above the assumed boundary height set between the first height and the second height in a case where a difference between the temperatures or the air components at the first height and the second height is smaller than a predetermined value and a change in blow-out air volume of the conditioned air supplied into the room is an increasing tendency, and determines that the boundary height of the stratification in the room is below the assumed boundary height set between the first height and the second height in a case where the difference between the temperatures or the air components at the first height and the second height is smaller than the predetermined value and the change in the blow-out air volume of the conditioned air supplied into the room is a decreasing tendency.

[0012]

In the replacement air-conditioning system according to any one of the third aspect to the fifth aspect, in a replacement air-conditioning system according to a sixth

aspect of the present disclosure, the detection unit detects a temperature or an air component at a third height that is set above the first height, the temperature or the air component at the third height includes a temperature or an air component in a discharge path of the indoor air, and the control unit derives the information regarding the boundary height of the stratification in the room based on the temperatures or the air components at the first height, the second height, and the third height.

[0013]

In the replacement air-conditioning system according to any one of the first aspect to the sixth aspect, in a replacement air-conditioning system according to a seventh aspect of the present disclosure, an air volume or a temperature of the conditioned air to be supplied into the room is adjusted such that a boundary height of the stratification in the room approaches the assumed boundary height in accordance with information regarding the boundary height of the stratification acquired based on the temperatures or the air components at the first height and the second height.

[0014]

In the replacement air-conditioning system according to any one of the first aspect to the seventh aspect, a replacement air-conditioning system according to an eighth

aspect of the present disclosure further includes a display unit that displays information indicating a boundary height of the stratification in accordance with information regarding the boundary height of the stratification acquired based on the temperatures or the air components at the first height and the second height.

[0015]

In the replacement air-conditioning system according to any one of the first aspect to the eighth aspect, in a replacement air-conditioning system according to a ninth aspect of the present disclosure, in a case where it is determined that a boundary of the stratification is not present between the first height and the second height based on the temperatures or the air components at the first height and the second height, warning information is output.

[0016]

An information processing method according to a tenth aspect of the present disclosure is executed by a computer, and includes acquiring temperatures or air components at a first height set above an assumed boundary height of stratification in a room and a second height set below the assumed boundary height, which are detected by a detection unit provided in a replacement air-conditioning system configured to be able to form the stratification of a temperature or an air component in the room by supplying

conditioned air to a lower side in the room and discharging indoor air from an upper side in the room, and obtaining information regarding a boundary height of the stratification in the room based on the obtained temperatures or air components at the first height and the second height.

[0017]

An information processing method according to an eleventh aspect of the present disclosure is an information processing method executed by a computer, including acquiring temperatures or air components at a first height set above an assumed boundary height of stratification in a room and a second height set below the assumed boundary height, which are detected by a detection unit provided in a replacement air-conditioning system configured to be able to form the stratification of a temperature or an air component in the room by supplying conditioned air to a lower side in the room and discharging indoor air from an upper side in the room, and obtaining information regarding a boundary height of the stratification in the room based on the obtained temperatures or air components at the first height and the second height.

[0018]

According to the present disclosure, it is possible to detect information suitable for grasping a state of

temperature stratification.

Brief Description of Drawings

[0019]

Fig. 1 is a schematic diagram of a replacement air-conditioning system of the present embodiment.

Fig. 2 is a block diagram illustrating a configuration example of a control device.

Fig. 3 depicts graphs representing simulation results of a relationship between a height in a room and an air temperature in the replacement air-conditioning system of the embodiment.

Fig. 4 is a flow chart illustrating a determination process by the control device.

Fig. 5 is a schematic diagram illustrating another configuration of the replacement air-conditioning system.

Fig. 6 is a schematic diagram of a replacement air-conditioning system of a second embodiment.

Fig. 7 is a flow chart illustrating a determination process by a control device of the second embodiment.

Fig. 8 is a schematic diagram of a replacement air-conditioning system 100 of a fourth embodiment.

Fig. 9 is a flow chart illustrating a determination process by a control device of the fourth embodiment.

Description of Embodiments

[0020]

The present disclosure will be specifically described with reference to the drawings illustrating embodiments thereof.

[0021]

(First embodiment)

Fig. 1 is a schematic diagram of a replacement air-conditioning system 100 of the present embodiment. The replacement air-conditioning system 100 of the present embodiment is a system that performs replacement air-conditioning by supplying fresh conditioned air into a room 1 surrounded by a ceiling surface 11, a wall surface 12, and a floor surface 13 and discharging indoor air having a high contaminant concentration in the room. The room 1 is an example of a target space for replacement air-conditioning by the replacement air-conditioning system 100. The target space is, for example, an indoor space of an office building, a house, a hospital, a restaurant, a live house, a school, a factory, or a warehouse. In the present embodiment, a case where the replacement air-conditioning system 100 is applied to the office building will be described as an example.

[0022]

The replacement air-conditioning system 100 supplies conditioned air into a room such that a clean zone (stratification zone) where cleanliness is to be secured

becomes equal to or higher than a height of a residential zone. The residential zone is a space in which people often act in the room 1. The residential zone may be a space from the floor surface 13 to the same height as a height of the head of a person in the room (a person staying in the room) or slightly above the height of the head. The height of the head of the person in the room varies depending on an assumed main posture of the person staying in the room, and is, for example, a height of the head in a case where the person is in a sitting position on a chair, a height of the head in a case where the person is in a standing position, or a height of the head in a case where the person is in a lying position on a floor or a sitting position on a floor. The height of the head of the person may be set in advance by a command to a control device to be described later. In the present embodiment, since the sitting position on the chair is mainly assumed as the posture of the person staying in the room in the office building, for example, the height of the head of the person is 1.2 m above the floor, and the residential zone may be 1.3 m or less from the floor surface 13. In a case where the posture of the person in the room is the standing position, for example, the height of the head of the person is 1.7 m above the floor, and the residential zone may be 1.8 m or less from the floor surface 13. In a case where the posture of the person in the room is the

lying position on the floor or the sitting position on the floor, for example, the height of the head of the person is 0.9 m above the floor, and the residential zone may be 1.0 m or less from the floor surface 13.

[0023]

The replacement air-conditioning system 100 includes an air conditioner 2, blow-out ports 3, intake ports 4, detection devices 5, a display device 6, a control device 7, and the like.

[0024]

The air conditioner 2 includes an outdoor unit (not illustrated) and an indoor unit 21. The air conditioner 2 air-conditions the room such as heating and cooling of the room by a replacement air-conditioning method. The outdoor unit is, for example, a chiller, and includes a compressor, a heat-source-side heat exchanger, a utilization-side heat exchanger, and the like. The indoor unit 21 includes a casing 22 and a cleaning and temperature adjusting unit 23 or the like housed in the casing 22. The indoor unit 21 and the outdoor unit are connected to each other by a water pipe to form a circulation circuit. The circulation circuit exchanges heat between water (circulating water) and a refrigerant to generate chilled water.

[0025]

The indoor unit 21 is provided indoors and is provided

outdoors of the room 1 (outside the wall surface 12). An outside air duct 81, a return air duct 82, and a supply air duct 83 are connected to the casing 22, and an air circuit (not illustrated) is formed inside the casing 22. The outside air duct 81 has an inflow end opened to an outdoor space and an outflow end connected to an inlet of the air circuit of the casing 22. The return air duct 82 has an inflow end connected to an attic space and an outflow end connected to an inlet of the air circuit of the casing 22. The intake ports 4 are directly connected to the attic space, and the attic space functions as a duct of the intake ports 4. The supply air duct 83 has an inflow end connected to an outlet of the air circuit of the casing 22 and an outflow end connected to the blow-out ports 3. In this way, the indoor unit 21 is directly connected to the intake ports 4 via the return air duct 82 and the attic space, and is directly connected to the blow-out ports 3 via the supply air duct 83.

[0026]

The cleaning and temperature adjusting unit 23 cleans and temperature-adjusts outside air sent from the outside air duct 81 and indoor air as indoor circulating air sent from the return air duct 82. The cleaning and temperature adjusting unit 23 includes a filter 231, a cooling coil 232, and a fan 233. The outside air and the indoor circulating

air sent into the casing 22 pass through the filter 231 and the cooling coil 232 in this order.

[0027]

The filter 231 collects dust in the outside air and the indoor circulating air. The filter 231 realizes a cleaning function of the cleaning and temperature adjusting unit 23. The cooling coil 232 is a heat exchanger and realizes a temperature adjustment function of the cleaning and temperature adjusting unit 23. The fan 233 conveys, to the supply air duct 83, the air having passed through the filter 231 and the cooling coil 232, that is, the conditioned air cleaned and temperature-adjusted.

[0028]

The method for cleaning the air is not limited to the collection by the filter 231 using the filter 231, and any method may be used as long as contaminants in the air can be removed or inactivated. The contaminants include, for example, CO₂, viruses, and the like contained in human breath. The cleaning and temperature adjusting unit 23 may include, for example, an ultraviolet light emitting device to clean the air by ultraviolet irradiation. The cleaning and temperature adjusting unit 23 may include, for example, a discharge electrode and a counter electrode, and may clean air by streamer discharge. The cleaning and temperature adjusting unit 23 may include, for example, an electrostatic

precipitator to clean air by electrostatic precipitation.

[0029]

The indoor unit 21 may include a passage of an outside air system and a passage of an indoor circulating air system, and may be configured to separately clean and temperature-adjust the outside air and the indoor circulating air. In this case, the filter 231 is not necessarily provided in the passage of the outside air system. The outside air and the indoor circulating air having passed through the indoor unit 21 may be mixed, flow through the supply air duct 83, and be blown out from each of the blow-out ports 3. Alternatively, the supply air duct 83 and the blow-out ports 3 may be provided to correspond to the passage of the outside air system and the passage of the indoor circulating air system, and each of the outside air and the indoor circulating air may be blown out from each blow-out port 3 without being mixed.

[0030]

A plurality of blow-out ports 3 are provided in the ceiling surface 11. In the example illustrated in Fig. 1, the replacement air-conditioning system 100 includes three blow-out ports 3. The blow-out ports 3 blow out the conditioned air conveyed from the indoor unit 21 via the supply air duct 83 toward the room. The number of blow-out ports 3 may be two or less or four or more.

[0031]

The blow-out port 3 includes a housing 31 having an air supply port (not illustrated), and a blow-out tube 32 formed in a lower wall of the housing 31. The blow-out tube 32 is opened toward the floor surface 13. A lower end edge of the blow-out tube 32 is positioned on a plane orthogonal to an axis of the blow-out tube 32. The blow-out port 3 is positioned such that the axis of the blow-out tube 32 is in a vertical direction. The conditioned air flowing through the supply air duct 83 in a horizontal direction flows into the housing 31 from the air supply port, bends a flow path, and is blown out from the blow-out tube 32. The blow-out port 3 linearly blows out the conditioned air in a downward direction from the ceiling surface 11 toward the floor surface 13. Specifically, the blow-out port 3 blows out the conditioned air downward in the vertical direction. An axial direction of the blow-out tube 32 and a blow-out direction of the blow-out port 3 are not limited to the vertical direction, and it is sufficient that the axial direction and the blow-out direction are substantially vertical directions, directions orthogonal to the floor surface 13, or directions substantially orthogonal to the floor surface 13. A shape of an opening in the blow-out port 3 is not limited to a circular shape and may be, for example, an elliptical shape, a polygonal shape, or the like.

[0032]

The blow-out port 3 may include an openable and closable lid body and may be configured to be able to control an open state of the blow-out tube 32. For example, the blow-out tube 32 may be switchable between an open state and a closed state, or an opening degree of the blow-out tube 32 in the open state may be adjustable.

[0033]

The blow-out port 3 is preferably installed in a region of the ceiling surface 11 other than a region above the person in the room. The region of the person in the room may be a region specified based on a layout of the room, a use mode, and the like, and a region in which the person staying in the room likely to stay for a relatively long period of time. The installation position of the blow-out port 3 may be determined in consideration of, for example, positions of the wall surface 12, an appliance in the room, the intake ports 4, and other blow-out ports 3 in a case where the plurality of blow-out ports 3 are provided.

[0034]

A plurality of intake ports 4 are also provided in the ceiling surface 11. In the example illustrated in Fig. 1, the replacement air-conditioning system 100 includes two intake ports 4. The intake ports 4 takes in indoor air containing contaminants. The number of intake ports 4 may be

one or three or more.

[0035]

The blow-out ports 3 and the intake ports 4 is not necessarily provided in the ceiling surface 11, as long as they are installed on an upper side of the room. The blow-out ports 3 and the intake ports 4 may be installed, for example, in the supply air duct 83 and the return air duct 82 installed in the room. The replacement air-conditioning system 100 may include a discharge port (not illustrated) to discharge a part of the indoor air taken in from the intake ports 4 to the outside of the room.

[0036]

The detection device 5 is a sensor that detects an indoor air temperature. The detection device 5 corresponds to a detection unit. For example, a temperature sensor, an ultrasonic sensor, an infrared sensor, or the like can be used as the detection device 5. The detection device 5 detects an air temperature at predetermined or appropriate time intervals and outputs data indicating the detected temperature to the control device 7.

[0037]

The detection device 5 detects a first temperature indicating an air temperature at a first height in the room and a second temperature indicating an air temperature at a second height below the first height in the vertical

direction. In the example illustrated in Fig. 1, the detection device 5 includes a first detection device 51 disposed at a detection place of the first temperature at the first height, and a second detection device 52 disposed at a detection place of the second temperature at the second height. The first detection device 51 detects, as the first temperature, an air temperature around an installation position of the first detection device 51. The second detection device 52 detects, as the second temperature, an air temperature around an installation position of the second detection device 52.

[0038]

As will be described in detail later, the control device 7 determines whether a boundary of temperature stratification is present between the first height and the second height based on the first temperature and the second temperature detected by the detection device 5. The first height and the second height are set as positions sandwiching an assumed boundary height of the temperature stratification in the room. The assumed boundary height of the temperature stratification means a height of a boundary surface of the temperature stratification assumed in the room. The first height is set above the assumed boundary height of the temperature stratification, and the second height is set below the assumed boundary height of the

assumed temperature stratification. The first height may be set above the head of the person in the room. Any one of the first height and the second height may be set as the same height as the assumed boundary height.

[0039]

The assumed boundary height of the temperature stratification, the first height, and the second height differ depending on the assumed posture of the person or a height of the head of the person corresponding to the posture. The first height and the second height are set in advance by a user, for example, prior to determining whether the boundary of the temperature stratification is present.

[0040]

In a case where the posture of the person staying in the room is the sitting position on the chair, for example, the assumed boundary height of the temperature stratification is 1.5 m, the first height is 1.5 m to 1.9 m above the floor, and the second height is 1.0 m to 1.4 m above the floor. In a case where the person staying in the room is at the sitting position on the chair, the first height is preferably 1.6 m above the floor, and the second height is preferably 1.2 m above the floor.

[0041]

Alternatively, in a case where the person staying in the room is at the sitting position on the chair, for

example, the assumed boundary height of the temperature stratification as a lower limit is 1.3 m, the first height is 1.3 m to 1.5 m above the floor, and the second height is 0.6 m to 1.2 m above the floor. In a case where the person staying in the room is at the sitting position on the chair, the first height is preferably 1.4 m above the floor, and the second height is preferably 1.0 m above the floor.

[0042]

In a case where the posture of the person staying in the room is the standing position, for example, the assumed boundary height of the temperature stratification is 1.9 m, the first height is 1.9 m to 2.2 m above the floor, and the second height is 1.5 m to 1.8 m above the floor. In a case where the person staying in the room is at the standing position, the first height is preferably 2.0 m above the floor, and the second height is preferably 1.6 m above the floor.

[0043]

In a case where the posture of the person staying in the room is the lying position on the floor or the sitting position on the floor, for example, the assumed boundary height of the temperature stratification is 1.1 m, the first height is 1.1 m to 1.6 m above the floor, and the second height is 0.6 m to 1.0 m above the floor. In a case where the person staying in the room is in the lying position on

the floor or the sitting position on the floor, the first height is preferably 1.2 m above the floor, and the second height is preferably 0.7 m above the floor.

[0044]

The detection device 5 also preferably detects an air temperature outside a passage region through which an airflow caused by the conditioned air from the blow-out ports 3 passes from the blow-out ports 3 to the floor surface 13. Specifically, it is preferable that the detection device 5 detects a temperature of a space outside a space directly below a lower end surface of the blow-out port 3 toward the floor surface 13 in the residential zone in the room. The lower end surface of the blow-out port 3 means a surface surrounded by an outer frame of a lower end of the blow-out port 3 (in the present embodiment, a lower end edge of the blow-out tube 32). The space directly below the lower end surface of the blow-out port 3 toward the floor surface 13 corresponds to a three dimensional region from the lower end surface of the blow-out port 3 to the floor surface 13 including a range overlapping the lower end surface as viewed in the vertical direction. Thus, the air temperature can be suitably detected without being affected by a temperature change generated in the passage region of the conditioned air.

[0045]

The detection device 5 may be installed at an appropriate position as long as the detection device can detect the air temperature at the detection place. For example, in a case where the infrared sensor is used as the detection device 5, the infrared sensor may be installed at the first height or the second height and at a position (for example, the wall surface 12 or the like) different from the detection place of the air temperature in the horizontal direction. The infrared sensor detects the air temperature of the detection place set at a position apart from the installation position of the detection device 5. A plurality of detection devices 5 may or may not be installed as the detection device. For example, the first temperature and the second temperature may be detected by one infrared camera capable of imaging a wide range in the room.

[0046]

The display device 6 notifies the user of information on an air environment in the room, in particular on a boundary surface height of the temperature stratification. The display device 6 corresponds to a display unit. The display device 6 includes, for example, a display device such as a liquid crystal panel or an organic electro luminescence (EL) display, an LED lamp, or the like. The display device 6 may be replaced with an output device to notify the user by other means such as sound. The display

device 6 displays various kinds of information to be notified to the user in accordance with an instruction from the control device 7 to be described later.

[0047]

The control device 7 is a computer and controls each device of the replacement air-conditioning system 100. The control device 7 controls an operation of the air conditioner 2 and adjusts a blow-out air volume and a blow-out temperature of the conditioned air from the blow-out ports 3.

[0048]

Fig. 2 is a block diagram illustrating a configuration example of the control device 7. The control device 7 includes a control unit 71, a storage unit 72, a communication unit 73, an input and output unit 74, and the like.

[0049]

The control unit 71 includes an arithmetic processing device such as a central processing unit (CPU) or a graphics processing unit (GPU). The control unit 71 executes various programs stored in the ROM or the storage unit 72 by using a built-in memory such as a read only memory (ROM) or a random access memory (RAM), a clock, a counter, and the like, and controls an operation of each of the hardware units described above. The storage unit 72 includes a nonvolatile

storage device such as a hard disk, an electrically erasable programmable ROM (EEPROM), or a flash memory. The storage unit 72 stores various computer programs and data to be referred to by the control unit 71. The communication unit 73 includes a communication device that realizes communication via a communication network.

[0050]

The input and output unit 74 includes an input and output device for connecting an external device. The air conditioner 2, the blow-out ports 3, the detection devices 5, the display device 6, and the like are connected to the input and output unit 74 in a wired or wireless manner. The control unit 71 outputs a control signal to the air conditioner 2, the blow-out ports 3, and the display device 6 via the input and output unit 74, and receives detection values output from the detection devices 5 via the input and output unit 74.

[0051]

In the replacement air-conditioning system 100 having the above configuration, outside air, which is fresh air introduced from an outside of a building, and indoor air containing contaminants taken in from the room via the intake ports 4 are conveyed to the air conditioner 2. The outside air and the indoor air conveyed to the air conditioner 2 are cleaned by the filter 231, and sent out,

as conditioned air cooled or heated to a predetermined temperature by the cooling coil 232, at a predetermined air volume by the fan 233.

[0052]

The conditioned air sent out from the air conditioner 2 is linearly blown out vertically downward in the room from the blow-out ports 3. The blow-out ports 3 blow out the conditioned air such that the conditioned air from the blow-out ports 3 of the ceiling surface 11 forms a unidirectional flow vertically downward from the blow-out ports 3 and directly reaches the floor surface 13. The conditioned air blown out from the blow-out ports 3 reaches the vicinity of the floor surface 13. Warm indoor air heated by a person as a heating element naturally rises on an ascending airflow. The indoor air contains contaminants. A part of the naturally ascending warm indoor air is taken into the intake ports 4 and is conveyed to the air conditioner 2.

[0053]

In the replacement air-conditioning system 100, a wind speed of the blow-out port 3 is set to be relatively low, and thus, it is possible to reduce entrainment of the indoor air of the airflow caused by the conditioned air while suppressing turbulence of the airflow of the conditioned air from the blow-out port 3. As a result, the temperature stratification is favorably formed, and thus, the setting of

the wind speed to be relatively low is suitable. An average wind speed of the conditioned air at the blow-out port 3 can be appropriately set in consideration of the size, shape, and the like of the room 1. The average wind speed at the blow-out port 3 can be, for example, 1.2 m/s or less.

[0054]

In this way, the stratification of a temperature and an air component is formed in the room. As illustrated in Fig. 1, a lower part of the room, that is, a clean zone (stratification zone) including the residential zone is filled with low-temperature and clean air. In an upper part of the room, that is, in a mixing zone above the clean zone, a layer of air at a high temperature and containing contaminants is formed. A boundary surface between the clean zone and the mixing zone is the boundary of the stratification (temperature stratification). The boundary of the temperature stratification usually occurs at a height at which a volume of ascending airflow in the room is equal to the amount of supply air (the amount of conditioned air) supplied to the room.

[0055]

In the replacement air-conditioning system 100, the first temperature and the second temperature are detected by the detection device 5 at predetermined or appropriate time intervals. The control device 7 executes a determination

process related to the boundary height of the temperature stratification in the room based on the detected first temperature and second temperature. The control device 7 adjusts a target blow-out air volume and a target blow-out temperature in the blow-out port 3 in accordance with the determination result. In the present embodiment, the information on the boundary height of the temperature stratification obtained by the control device 7 includes the presence or absence of the boundary of the stratification between the first height and the second height and a high-low level relationship between the assumed boundary height and the boundary height of the stratification in the room.

[0056]

The method for determining the boundary height of the temperature stratification executed by the control device 7 of the present embodiment will be described. First, a relationship between the boundary height of the temperature stratification and the air temperature will be described.

[0057]

Fig. 3 depicts graphs representing simulation results of a relationship between a height in a room and an air temperature in the replacement air-conditioning system 100 of the embodiment. The following simulations are based on computational fluid dynamics (CFD) simulations. Fig. 3A represents the relationship between the height in the room

and the air temperature in a case where an indoor heat generation amount in the room is large. Fig. 3B represents the relationship between the height in the room and the air temperature when the indoor heat generation amount is small. In the graphs represented in Figs. 3A and 3B, a vertical axis represents the height in the room (unit: m), and a horizontal axis represents the air temperature (unit: °C). Fig. 3A and Fig. 3B both represent an example of a case where the boundary height of the assumed temperature stratification is 1.8 m.

[0058]

In Fig. 3A, a solid line indicates a change in the air temperature in a case where the blow-out air volume is appropriate, and a broken line indicates a change in the air temperature in a case where the blow-out air volume is excessively large. As represented in Fig. 3A, an air temperature at a room height of 1.8 m is about 26.0°C in both the case where the blow-out air volume is appropriate and the case where the blow-out air volume is excessively large. On the other hand, from Fig. 3A, it can be seen that the boundary of the temperature stratification occurs at about 1.8 m which is assumed in a case where the blow-out air volume is appropriate, but occurs at about 2.6 m in a case where the blow-out air volume is excessively large.

[0059]

In Fig. 3B, a solid line indicates a change in the air temperature in a case where the blow-out air volume is appropriate, and a broken line indicates a change in the air temperature in a case where the blow-out air volume is excessively small. As represented in Fig. 3B, an air temperature at a room height of 1.8 m is about 26.0°C in both of the case where the blow-out air volume is appropriate and the case where the blow-out air volume is excessively small. On the other hand, from Fig. 3B, it can be seen that the boundary of the temperature stratification occurs at about 1.8 m which is assumed in a case where the blow-out air volume is appropriate, but occurs at about 1.4 m in a case where the blow-out air volume is excessively small.

[0060]

From Fig. 3A and Fig. 3B, it can be seen that even though the air temperature at the boundary height of the assumed temperature stratification is the same, an actual boundary height of the temperature stratification differs. That is, even in a case where the air temperature at the boundary height of the temperature stratification assumed in advance becomes a predetermined value, there is a possibility that the boundary of the temperature stratification is not at the assumed height position. Therefore, an actual state of the temperature stratification

is not necessarily taken into consideration when control is performed such that the air temperature at the boundary height of the temperature stratification assumed in advance is simply measured and the blow-out air volume of conditioned air is adjusted based on, for example, the magnitude of the obtained measured value. In the replacement air-conditioning method, since the state of the temperature stratification changes in accordance with the heat generation amount in the room and the position of the heating element, it is important to grasp the actual state of the boundary of the temperature stratification in order to appropriately adjust the air environment in the room.

[0061]

In the present embodiment, the air temperatures at two places in the vertical direction are detected, and thus, the control unit 71 determines whether the boundary of the temperature stratification is present between the two places. That is, based on the air temperatures at the two places in the vertical direction, it is determined whether or not the actual boundary of the temperature stratification is present in the vicinity of the assumed value (assumed boundary height) of the boundary height of the temperature stratification set in advance. Effective replacement air-conditioning is realized by adjusting the blow-out capacity of the blow-out port 3 in accordance with the determination

result of whether the boundary is present.

[0062]

Fig. 4 is a flow chart illustrating the determination process performed by the control device 7. The control device 7 stores the assumed boundary height of the temperature stratification in the storage unit 72 in advance in the execution of the determination process. The control device 7 repeatedly executes the following process at predetermined or appropriate time intervals during the operation of the air conditioner 2, for example.

[0063]

The control unit 71 of the control device 7 acquires the first temperature indicating the air temperature at the first height and the second temperature indicating the air temperature at the second height which are detected by the detection device 5 (step S11).

[0064]

The control unit 71 determines whether the boundary of the temperature stratification is present between the first height and the second height based on the comparison between the acquired first temperature and second temperature (step S12). For example, the control unit 71 determines whether the boundary of the temperature stratification is present by determining whether or not a difference between the first temperature and the second temperature is equal to or larger

than a preset temperature threshold value. In a case where the difference between the first temperature and the second temperature is smaller than the preset threshold value, it can be determined that the boundary of the temperature stratification is not present between the first height and the second height. In a case where the difference between the first temperature and the second temperature is equal to or larger than the preset threshold value, it can be determined that the boundary of the temperature stratification is present between the first height and the second height can be determined.

[0065]

In a case where it is determined that the boundary of the temperature stratification is not present between the first height and the second height (step S12: NO), the control unit 71 determines a high-low level relationship between the assumed boundary height set in advance and a current boundary height of the temperature stratification (step S13). In step S13, the control unit 71 determines the high-low level relationship based on the determination result that the boundary of the temperature stratification is not present between the first height and the second height, and the blow-out air volume in the blow-out port 3.

[0066]

Specifically, the control unit 71 determines whether a

change in the blow-out air volume is an increasing tendency or a decreasing tendency based on time-series data of the blow-out air volume within a latest predetermined time. In a case where the boundary of the temperature stratification is not present between the first height and the second height and the blow-out air volume has the increasing tendency, the control unit 71 determines that the current boundary of the temperature stratification is higher than the assumed boundary height set in advance. In a case where the boundary of the temperature stratification is not present between the first height and the second height and the blow-out air volume has the decreasing tendency, the control unit 71 determines that the current boundary of the temperature stratification is lower than the assumed boundary height set in advance.

[0067]

It is assumed that there is no variation in the number of heating elements (for example, people, electronic devices, and the like) of which the number in the room can vary and the heat generation amount in the room increases due to an increase in a heat entering amount from heating elements (for example, windows and the like) of which the number does not vary and of which heat can vary. In this case, since a heat generation area in the room does not change, an air volume of the ascending airflow increases

only slightly. When the blow-out air volume into the room is increased, since a supply amount of conditioned air becomes excessively large with respect to the air volume of the ascending airflow, it is considered that the boundary of the temperature stratification becomes equal to or higher than the assumed height. Therefore, in a case where a change in the blow-out air volume of the conditioned air supplied into the room is the increasing tendency, it can be determined that a current boundary of the temperature stratification is higher than the assumed boundary height. In a case where the change in the blow-out air volume of the conditioned air supplied into the room is the decreasing tendency, it can be determined that the current boundary of the temperature stratification is lower than the assumed boundary height. The change in the blow-out air volume of the conditioned air can be specified by, for example, analyzing the blow-out air volume within the latest predetermined time. The blow-out air volume means the volume of the conditioned air blown out from the blow-out port 3.

[0068]

In step S13, in a case where the blow-out air volume is constant, the control unit 71 may determine whether or not the current blow-out air volume is equal to or larger than a preset air volume threshold value. In a case where the boundary of the temperature stratification is not present

between the first height and the second height and the constant blow-out air volume is equal to or larger than the air volume threshold value, the control unit 71 determines that the current boundary of the temperature stratification is higher than the assumed boundary height set in advance. In a case where the boundary of the temperature stratification is not present between the first height and the second height, and the certain blow-out air volume is smaller than the air volume threshold value, the control unit 71 determines that the current boundary of the temperature stratification is lower than the assumed boundary height set in advance.

[0069]

The control unit 71 generates warning information regarding the boundary height of the temperature stratification based on the determination result of the presence or absence of the boundary and the high-low level relationship, and causes the display device 6 to display the generated warning information (step S14). The warning information includes, for example, information notifying the user that the current boundary height of the temperature stratification deviates from the assumed boundary height. The control unit 71 may store correspondence information between the determination result of the high-low level relationship and the warning information to be output in the

storage unit 72 in advance. For example, in a case where it is determined that the current boundary of the temperature stratification is lower than the assumed boundary height, the entrance restriction for a predetermined time may be output as the warning information. The control unit 71 may output the warning information to a device other than the display device 6. The control unit 71 may transmit the warning information to, for example, a manager of the room 1. The control unit 71 proceeds the process to step S16.

[0070]

In a case where it is determined that the boundary of the temperature stratification is present between the first height and the second height (step S12: YES), the control unit 71 causes the display device 6 to display information indicating the boundary height of the temperature stratification (step S15). For example, the control unit 71 may cause the display device 6 to display the assumed boundary height set between the first height and the second height, as a current temperature stratification height. In step S15, the control unit 71 may display information indicating whether the boundary height of the temperature stratification is present. The control unit 71 may notify the user that the boundary of the temperature stratification is present in the vicinity of the assumed boundary height, for example, by turning on an LED lamp of the display device

6. The control unit 71 proceeds the process to step S16.
[0071]

The control unit 71 adjusts the target blow-out temperature and the target blow-out air volume in the blow-out port 3 based on the determination result of the presence or absence of the boundary or the determination result of the presence or absence of the boundary and the high-low level relationship (step S16). In a case where the boundary of the temperature stratification is present between the first height and the second height, the control unit 71 maintains the target blow-out temperature and the target blow-out air volume without changing the target blow-out temperature and the target blow-out air volume, for example. In a case where the boundary of the temperature stratification is not present between the first height and the second height, the control unit 71 adjusts the target blow-out air volume in accordance with, for example, whether the current boundary height of the temperature stratification is higher or lower than the assumed boundary height. In a case where the current boundary height of the temperature stratification is higher than the assumed boundary height, since it is considered that the supply amount of the conditioned air is excessive, it is possible to suppress excessive energy consumption by reducing the target blow-out air volume. In a case where the current

boundary height of the temperature stratification is lower than the assumed boundary height, since it is considered that the supply amount of the conditioned air is insufficient, the cleanliness of the residential zone can be improved by increasing the target blow-out air volume. The control unit 71 may adjust the target blow-out temperature in accordance with whether the current boundary height of the temperature stratification is higher or lower than the assumed boundary height.

[0072]

The control unit 71 transmits a control signal for controlling the operation of the air conditioner 2 to the air conditioner 2 such that the blow-out temperature and the blow-out air volume of the conditioned air from the blow-out port 3 become derived target blow-out temperature and target blow-out air volume (step S17).

[0073]

The blow-out air volume is adjusted, for example, by varying a frequency of the fan 233. The blow-out air volume can be adjusted in accordance with an increase or decrease in the frequency. The blow-out temperature is adjusted, for example, by varying the water supply capacity of a chilled water pump for supplying (circulating) chilled water, that is, the displacement of the pump. Thus, the amount of water (mass flow rate) per unit time supplied by the chilled water

pump can be varied, and the level of the blow-out temperature can be adjusted in accordance with an increase or decrease in the amount of water. Alternatively, in a chiller or the like serving as a cold heat source of the chilled water, a temperature (water temperature) of chilled water supplied to a space to be air-conditioned may be adjusted by adjusting an evaporation temperature of a heat exchanger for cooling the chilled water. The blow-out temperature may thus be adjusted. The level of the blow-out temperature can be adjusted according to the level of the temperature of the chilled water.

[0074]

The control device 7 may transmit, to the blow-out port 3, a control signal for controlling opening or closing of the blow-out port 3 such that the blow-out air volume of the conditioned air from the blow-out port 3 becomes the derived target blow-out air volume. For example, the control device 7 transmits, to the blow-out port 3, a control signal for controlling an opening degree of the blow-out port 3 such that the blow-out air volume at the blow-out port 3 becomes the derived target blow-out air volume.

[0075]

The control device 7 may determine the number of blow-out ports 3 from which the conditioned air is blown out, based on a target blow-out air volume as a required total

blow-out air volume derived in accordance with a target value of the temperature in the room and the blow-out air volume in each blow-out port 3. The control device 7 may determine the number of blow-out ports 3 such that the blow-out air volume from each blow-out port 3 is equal to or less than a predetermined value. For example, the control device 7 selects the blow-out port 3 from which the conditioned air is blown out based on the determined number of blow-out ports 3 and the installation position of the blow-out ports 3. The control device 7 transmits a control signal to each blow-out port 3 so as to open only the selected blow-out port 3. The control unit 71 ends the series of processes.

[0076]

The replacement air-conditioning system and the information processing method can also be applied to replacement ventilation air-conditioning in which blow-out ports are installed in a lower side of a room, such as an underfloor or a lower part of a wall surface and conditioned air is directly supplied to a lower part of the room.

[0077]

With the replacement air-conditioning system 100 and the like according to the present embodiment, it is possible to realize replacement ventilation air-conditioning in which conditioned air is directly supplied to a floor surface from the upper side of the room. The blow-out ports 3 are

installed on the upper side of the room, and thus, the dependency on construction is low and the installation is easy as compared with a case where the blow-out ports 3 are installed in the underfloor.

[0078]

The air temperatures at the upper and lower positions of the assumed boundary height of the temperature stratification detected by the detection device 5 are analyzed, and thus, the control unit 71 can easily and accurately determine whether the actual boundary of the temperature stratification is present in the vicinity of the assumed boundary height. The blow-out capacity of the blow-out port 3 is adjusted in accordance with the determination result, and thus, air-conditioning corresponding to an actual formation situation of the temperature stratification can be performed.

[0079]

The high-low level relationship between the assumed boundary height and the current boundary height is determined in addition to the presence or absence of the boundary in the vicinity of the assumed boundary height, and thus, it is possible to specify a state of the high-low level of the boundary height. As a result, it is possible to more accurately grasp the air environment in the room. Since it is possible to control the boundary height of the

temperature stratification to a desired height by appropriately controlling the blow-out capacity of the blow-out port in accordance with the specified state of the high-low level of the boundary height, it is possible to improve the cleanliness and energy saving of the replacement air-conditioning system 100.

[0080]

The warning information is presented in accordance with various determination results, and thus, the user can recognize the warning information at an early stage. As a result, convenience is improved. The boundary height of the temperature stratification is displayed on the display device 6, and thus, the person staying in the room can grasp the state of the temperature stratification at a glance. As a result, convenience is improved.

[0081]

The assumed boundary height, the first height, and the second height are appropriately set in accordance with an assumed use mode of the room 1, and thus, the boundary height of the temperature stratification can be controlled in accordance with the use mode of the room 1. The assumed boundary height is set in the vicinity of a lower limit value, and thus, the lowering of the boundary surface can be detected.

[0082]

(Modified example)

Fig. 5 is a schematic diagram illustrating another configuration of the replacement air-conditioning system 100. In the replacement air-conditioning system 100, indoor units 21 are installed above blow-out ports 3. In the example illustrated in Fig. 5, a plurality of indoor units 21 are provided so as to correspond to a plurality of blow-out ports 3, respectively. The indoor units 21 may be integrated with the blow-out ports 3 and may be disposed on the ceiling surface 11, for example. The indoor units 21 are connected to an outdoor unit (not illustrated) via a water pipe 9. The replacement air-conditioning system 100 does not necessarily include the outside air duct 81, the return air duct 82, or the supply air duct 83. Although the control device 7 is not illustrated in Fig. 5 for the sake of simplicity in description, each indoor unit 21 is connected to the control device 7 in a wired or wireless manner.

[0083]

The intake port 4 is formed on a lower side of the indoor unit 21. An air supply port 24 is provided on an upper side of the indoor unit 21. The indoor unit 21 performs intake of indoor air as indoor circulating air taken in from the intake port 4 and outside air introduced from the air supply port 24. Since an internal configuration of the indoor unit 21 is similar to that of the first

embodiment, a detailed description thereof will be omitted, but the indoor unit 21 directly sends the conditioned air cleaned and temperature-adjusted by the cleaning and temperature adjusting unit 23 to the blow-out port 3 therebelow. The intake port 4 is not limited to being provided in the indoor unit 21, and may be provided in the ceiling surface. The indoor circulating air and the outside air flow into the indoor unit 21 through the air supply port 24. The indoor unit 21 may perform intake of the indoor circulating air via the return air duct 82.

[0084]

With the above-described configuration, since various ducts such as the supply air duct 83 are not necessary, the configuration of the replacement air-conditioning system 100 is simplified, and installation is easy.

[0085]

(Second embodiment)

In a second embodiment, a configuration in which the first height and the second height are varied will be described. In the following embodiment, differences from the first embodiment will be mainly described, and configurations common to the first embodiment will be denoted by the same reference signs and detailed description thereof will be omitted.

[0086]

Fig. 6 is a schematic diagram of a replacement air-conditioning system 100 of the second embodiment. The replacement air-conditioning system 100 of the second embodiment includes, as the detection device 5, the first detection device 51 and the second detection device 52 installed at different heights on the wall surface 12 in the room. The first detection device 51 is provided above the second detection device 52. The first detection device 51 and the second detection device 52 are, for example, infrared sensors.

[0087]

Both the first detection device 51 and the second detection device 52 are fixed to the wall surface 12 in an angle-adjustable state, and thus, the detection height and the detection position of the air temperature can be changed.

[0088]

In the replacement air-conditioning system 100 of the second embodiment, a plurality of assumed boundary heights of the temperature stratification are prepared, and the first height and the second height corresponding to each assumed boundary height are set in advance. The detection device 5 is configured to be able to detect air temperatures at the first height and the second height corresponding to each assumed boundary height. For example, a detection

direction is switched, and thus, the first detection device 51 can detect air temperatures at a first detection place at a first height corresponding to a first assumed boundary height and a second detection place at a first height corresponding to a second assumed boundary height. The detection direction is switched, and thus, the second detection device 52 can detect air temperatures at a third detection place at the second height corresponding to the first assumed boundary height and a fourth detection place at the second height corresponding to the second assumed boundary height.

[0089]

Each of the first detection device 51 and the second detection device 52 may detect air temperatures at height positions corresponding to three or more assumed boundary heights. The configuration of the detection device 5 is not limited to the example described above, and may be any configuration as long as the detection device can detect the air temperatures at a plurality of first heights and second heights.

[0090]

A table (not illustrated) in which the assumed boundary height is associated with the first height and the second height is stored in the storage unit 72 of the control device 7.

[0091]

Fig. 7 is a flow chart illustrating a determination process performed by the control device 7 of the second embodiment.

[0092]

The control unit 71 of the control device 7 acquires the assumed boundary height of the temperature stratification (step S21). The control unit 71 may acquire the assumed boundary height, for example, by receiving designation of the assumed boundary height transmitted from an external device. The control unit 71 may recognize the posture of the person staying in the room based on an output from a person detection sensor (not illustrated), and may acquire the assumed boundary height corresponding to the recognized posture based on a correspondence relationship between the posture of the person and the assumed boundary height stored in advance.

[0093]

The control unit 71 acquires the first height and the second height corresponding to the acquired assumed boundary height based on information stored in the table of the storage unit 72, and outputs the acquired first height and second height to the detection device 5 (step S22). The detection device 5 detects the first temperature indicating the air temperature at the first height corresponding to the

assumed boundary height and the second temperature indicating the air temperature at the second height corresponding to the assumed boundary height, for example, by switching the detection direction according to the first height and the second height received from the control device 7.

[0094]

Thereafter, the control unit 71 executes the process of the flow chart illustrated in Fig. 4 to perform the process of determining whether the boundary of the temperature stratification is present in the vicinity of the acquired assumed boundary height.

[0095]

According to the present embodiment, the suitability of the current state of the temperature stratification can be determined for the plurality of assumed boundary heights. The replacement air-conditioning system 100 can be applied to various use environments in the room, and the utilization of the replacement air-conditioning system 100 is enhanced.

[0096]

(Third embodiment)

In a third embodiment, a configuration for detecting information suitable for grasping the state of the stratification of the air component will be described.

[0097]

The detection device 5 of the third embodiment is a sensor that detects an air component in the room. For example, an air component sensor can be used as the detection device 5. The air component sensor includes, for example, a carbon dioxide sensor, an odor sensor, an air particle sensor, and a biosensor. The detection device 5 may include two or more types of sensors described above. Examples of the air component detected by the detection device 5 include carbon dioxide, odorous substances, droplet nuclei, viruses, and combinations thereof.

[0098]

The detection device 5 detects a first concentration indicating a concentration of an air component at a first height and a second concentration indicating a concentration of an air component at a second height in the room.

[0099]

The replacement air-conditioning system 100 may be configured to detect each of the stratification of the temperature and the stratification of the air component by detecting both the temperature and the air component with the detection device 5.

[0100]

In the ceiling blow-out type replacement air-conditioning system 100 in which the blow-out port 3 is provided in the ceiling, the conditioned air blown out from

the blow-out port 3 is supplied to the lower part of the room while entraining the high-temperature and contaminant-containing air on an upper side of the room. Thus, a temperature gradient in the room becomes small, and the stratification height may be detected more suitably by using a concentration distribution of the air component than by using a temperature distribution in the vertical direction. The control device 7 of the third embodiment compares the first concentration and the second concentration detected by the detection device 5 to acquire information on the boundary height of the stratification of the air component in the room.

[0101]

The first temperature and the second temperature of the first embodiment are replaced with the first concentration and the second concentration, and a process similar to that of the first embodiment is executed. Thus, the control device 7 determines the boundary height of the stratification of the air component based on the first concentration and the second concentration (determines whether the boundary of the stratification of the air component is present between the first height and the second height). The control device 7 also executes various control processes and output processes in accordance with the obtained determination result of the boundary height of the

stratification of the air component.

[0102]

According to the present embodiment, it is possible to easily and accurately determine whether the actual boundary of the stratification is present in the vicinity of the assumed boundary height in consideration of the air component. Even in a case where the temperature gradient is small, the boundary height of the stratification can be determined based on a concentration gradient of the air component. The determination accuracy of the boundary height of the stratification can be improved by considering both the temperature and the air component in the room by the detection device.

[0103]

(Fourth embodiment)

In a fourth embodiment, a configuration for further detecting a temperature or an air component at a third height will be described.

[0104]

Fig. 8 is a schematic diagram of a replacement air-conditioning system 100 of the fourth embodiment. The replacement air-conditioning system 100 of the fourth embodiment further includes a third detection device 53 as the detection device 5 in addition to the first detection device 51 and the second detection device 52. The first

detection device 51 detects a first temperature indicating an air temperature at a first height set above the assumed boundary height. The second detection device 52 detects a second temperature indicating an air temperature at a second height set below the assumed boundary height. The third detection device 53 detects a third temperature indicating an air temperature at a third height set above the first height.

[0105]

The third temperature at the third height may be a temperature in a discharge path (return air path). In this system, the intake ports 4, the attic space, and the return air duct 82 constitute a discharge path of the indoor air. A heat insulating material may be provided in the discharge path. The indoor air is taken in from the intake ports 4, flows through the discharge path, and is sent to the cleaning and temperature adjusting unit 23. In the discharge path, it is assumed that the temperature and the state of the air component of the indoor air hardly change. Therefore, in a case where the third height is a height of the intake port 4 positioned on the upper side of the room and above the first height, the temperature and the concentration of the air component at the third height are substantially equal to the temperature and the concentration of the air component in the discharge path. Thus, the

temperature or the concentration of the air component at the third height corresponding to the height of the intake port 4 may be acquired by disposing the third detection device 53 at an appropriate position in the discharge path and detecting the temperature or the concentration of the air component in the discharge path by the third detection device 53. The third detection device 53 disposed in the discharge path may be provided below the first height.

[0106]

The control device 7 determines the height of the boundary of the temperature stratification in the room by comparing the acquired first temperature, second temperature, and third temperature. Fig. 9 is a flow chart illustrating a determination process performed by the control device 7 of the fourth embodiment.

[0107]

The control unit 71 of the control device 7 acquires the first temperature indicating the air temperature at the first height, the second temperature indicating the air temperature at the second height, and the third temperature indicating the air temperature at the third height, which are detected by the detection device 5 (step S31).

[0108]

The control unit 71 determines whether the boundary of the temperature stratification is present between the first

height and the second height and between the third height and the first height based on the acquired first temperature, second temperature, and third temperature (step S32). In step S32, the control unit 71 determines whether the boundary of the temperature stratification is present between the first height and the second height based on the comparison between the first temperature and the second temperature, and determines whether the boundary of the temperature stratification is present between the third height and the first height based on the comparison between the third temperature and the first temperature. Similarly to the first embodiment, the determination of whether the boundary of the temperature stratification is present between two height positions is performed by determining whether or not the difference (absolute value of the difference) between temperatures at the two height positions is less than a threshold value set in advance.

[0109]

The control unit 71 specifies the height of the boundary of the temperature stratification in the room based on each determination result, and determines a relative positional relationship between the preset assumed boundary height and the current boundary height of the temperature stratification (step S33). The relative positional relationship corresponds to information regarding the

boundary height of the stratification.

[0110]

In a case where it is determined that the boundary of the temperature stratification is present between the first height and the second height, the control unit 71 determines that the height of the boundary of the temperature stratification is between the first height and the second height and the current boundary height of the temperature stratification is in the vicinity of the assumed boundary height. In a case where it is determined that the boundary of the temperature stratification is present between the third height and the first height, the control unit 71 determines that the height of the boundary of the temperature stratification is between the third height and the first height and the current boundary height of the temperature stratification is higher than the assumed boundary height. In a case where the third height is set to a sufficiently high position in the room, it is considered that there is a low possibility that the boundary of the temperature stratification is present above the third height. Therefore, in a case where it is determined that the boundary of the temperature stratification is not present both between the first height and the second height and between the third height and the first height, the control unit 71 may determine that the current height of the

boundary of the temperature stratification is below the second height and the current height of the boundary of the temperature stratification is below the assumed boundary height. For example, the third height is set above the boundary height corresponding to the highest temperature stratification that can be formed in a case where the replacement air-conditioning system 100 is used at the normally assumed set temperature and set air volume, and thus, it is possible to reduce a possibility that the boundary of the temperature stratification is present above the third height.

[0111]

Thereafter, the control unit 71 executes processes similar to step S15 to step S17 illustrated in Fig. 4, and thus, the display of the specified boundary height and the adjustment of the temperature or the air volume corresponding to the boundary height based on the specification result of the boundary height of the temperature stratification. The control unit 71 may display warning information as necessary.

[0112]

In the above-described processes, the control unit 71 may determine whether the boundary of the temperature stratification is present between the third height and the first height only in a case where it is determined that the

boundary of the temperature stratification is not present between the first height and the second height. In a case where the boundary of the temperature stratification is not present between the first height and the second height and the boundary of the temperature stratification is present between the third height and the first height, it can be determined that the current boundary height of the temperature stratification is above the assumed boundary height. In a case where the boundary of the temperature stratification is not present between the first height and the second height and the boundary of the temperature stratification is not present between the third height and the first height, it can be determined that the current boundary height of the temperature stratification is below the assumed boundary height.

[0113]

The specification of the height of the boundary of the temperature stratification is not limited to being performed based on the comparison of the temperature difference between the first height and the second height and the temperature difference between the third height and the first height. The height of the boundary of the temperature stratification may be specified based on a temperature difference in a combination of two different height positions among the first height, the second height, and the

third height. For example, the specification of the height of the boundary of the temperature stratification may be performed based on the temperature difference between the first height and the second height and the temperature difference between the third height and the second height, or may be performed based on the temperature difference between the first height and the third height and the temperature difference between the third height and the second height.

[0114]

Although an example of a case where the detection device 5 is the temperature sensor has been described above, the detection value by the detection device 5 may be the concentration of the air component.

[0115]

According to the present embodiment, the temperatures or the air components at three different heights in the room are detected, and thus, the current state of the temperature stratification can be determined more efficiently.

[0116]

The present invention is not limited to these examples, is defined by the claims, and is intended to include all modifications within the meaning and scope equivalent to the claims. At least a part of the above-described embodiments may be arbitrarily combined.

The sequence illustrated in each embodiment is not limited, and each processing procedure may be executed by changing the order thereof within a consistent range, and a plurality of processes may be executed in parallel. A processing subject of each process is not limited, and the process of each device may be executed by another device within a consistent range.

[0117]

The matters described in the embodiments can be combined with each other. The independent claims and the dependent claims recited in the claims can be combined with each other in any combination regardless of the form of citation. A form (multi-claim form) in which a claim citing two or more other claims is described is used in the claims, but the present invention is not limited thereto. Multiple claims may be presented in a form that recites at least one of the multiple claims.

Reference Signs List

[0118]

100 REPLACEMENT AIR-CONDITIONING SYSTEM

1 ROOM

11 CEILING SURFACE

12 WALL SURFACE

13 FLOOR SURFACE

2 AIR CONDITIONER

- 21 INDOOR UNIT
- 22 CASING
- 23 CLEANING AND TEMPERATURE ADJUSTING UNIT
- 231 FILTER
- 232 COOLING COIL
- 233 FAN
- 3 BLOW-OUT PORT
- 31 HOUSING
- 32 BLOW-OUT TUBE
- 33 LOWER END SURFACE
- 4 INTAKE PORT
- 5 DETECTION DEVICE
- 6 DISPLAY DEVICE
- 7 CONTROL DEVICE
- 71 CONTROL UNIT

CLAIMS

[Claim 1]

A replacement air-conditioning system configured to be able to form stratification of a temperature or an air component in a room by supplying conditioned air to a lower side of the room and discharging indoor air from an upper side of the room, the system comprising:

a detection unit that detects the temperature or the air component in the room,

wherein the detection unit detects temperatures or air components at a first height set above an assumed boundary height of the stratification in the room and a second height set below the assumed boundary height.

[Claim 2]

The replacement air-conditioning system according to claim 1, wherein the first height is set in advance as a height above a head of a person in the room.

[Claim 3]

The replacement air-conditioning system according to claim 1 or 2, further comprising:

a control unit,

wherein the control unit derives information regarding a boundary height of the stratification in the room based on the temperatures or the air components at the first height and the second height detected by the detection unit.

[Claim 4]

The replacement air-conditioning system according to claim 3, wherein the control unit determines whether a boundary of the stratification is present between the first height and the second height based on the temperatures or the air components at the first height and the second height.

[Claim 5]

The replacement air-conditioning system according to claim 3,

wherein the control unit

determines that the boundary height of the stratification in the room is above the assumed boundary height set between the first height and the second height in a case where a difference between the temperatures or the air components at the first height and the second height is smaller than a predetermined value and a change in blow-out air volume of the conditioned air supplied into the room is an increasing tendency, and

determines that the boundary height of the stratification in the room is below the assumed boundary height set between the first height and the second height in a case where the difference between the temperatures or the air components at the first height and the second height is smaller than the predetermined value and the change in the

blow-out air volume of the conditioned air supplied into the room is a decreasing tendency.

[Claim 6]

The replacement air-conditioning system according to claim 3,

wherein the detection unit detects a temperature or an air component at a third height that is set above the first height,

the temperature or the air component at the third height includes a temperature or an air component in a discharge path of the indoor air, and

the control unit derives the information regarding the boundary height of the stratification in the room based on the temperatures or the air components at the first height, the second height, and the third height.

[Claim 7]

The replacement air-conditioning system according to claim 1 or 2, wherein an air volume or a temperature of the conditioned air to be supplied into the room is adjusted such that a boundary height of the stratification in the room approaches the assumed boundary height in accordance with information regarding the boundary height of the stratification acquired based on the temperatures or the air components at the first height and the second height.

[Claim 8]

The replacement air-conditioning system according to claim 1 or 2, further comprising:

a display unit that displays information indicating a boundary height of the stratification in accordance with information regarding the boundary height of the stratification acquired based on the temperatures or the air components at the first height and the second height.

[Claim 9]

The replacement air-conditioning system according to claim 1 or 2, wherein, in a case where it is determined that a boundary of the stratification is not present between the first height and the second height based on the temperatures or the air components at the first height and the second height, warning information is output.

[Claim 10]

An information processing method executed by a computer, comprising:

acquiring temperatures or air components at a first height set above an assumed boundary height of stratification in a room and a second height set below the assumed boundary height, which are detected by a detection unit provided in a replacement air-conditioning system configured to be able to form the stratification of a temperature or an air component in the room by supplying conditioned air to a lower side in the room and discharging

indoor air from an upper side in the room; and

obtaining information regarding a boundary height of the stratification in the room based on the obtained temperatures or air components at the first height and the second height.