

CONTROL METHOD, PROGRAM, AND AIRFLOW CONTROL SYSTEM

Technical Field

[0001] The present disclosure generally relates to a control method, a program, and an airflow control system. More particularly, the present disclosure relates to a method for controlling an airflow control system, a program, and the airflow control system.

Background Art

[0002] Patent Literature 1 discloses a multi-functional blower configured to provide, for a predetermined local spot, various functions of the device's own including blowing air, air conditioning, adding fragrance, deodorization, and air purification.

[0003] In the multi-functional blower of Patent Literature 1, the volume of the air supplied is determined in advance with respect to the breadth of the local space as the target of air conditioning and air purification. Thus, some persons may find the air supplied chilly or uncomfortable, for example.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2003-287000 A

Summary of Invention

[0005] An object of the present disclosure is to provide a control method, a program, and an airflow control system having the ability to increase the degree of comfort.

[0006] A control method according to an aspect of the present disclosure is designed to control a system including an air blower and a supplier. The air blower has an outlet port, from which an airflow with a degree of straightness is allowed to blow out. The air blower may adjust a velocity of the airflow blowing out from the outlet port. The supplier may supply the airflow blowing out from the outlet port with a functional component to be eventually emitted into the air. The control method includes: performing fluctuation control on the velocity of the airflow blowing out from the outlet port; and allowing, when the velocity of the airflow is greater than a threshold value, the functional component to be supplied from the supplier to the airflow.

[0007] A program according to another aspect of the present disclosure is designed to cause a computer system to perform the control method described above.

[0008] An airflow control system according to still another aspect of the present disclosure includes an air blower, a supplier, and a control unit. The air blower has an outlet port, from which an airflow with a degree of straightness is allowed to blow out. The air blower may adjust a velocity of the airflow blowing out from the outlet port. The supplier may supply the airflow blowing out from the outlet port with a functional component to be eventually emitted into the air. The control unit controls the air blower and the supplier. The control unit controls the air blower to perform fluctuation control on the velocity of the airflow blowing out from the outlet port. The control unit controls the supplier to allow, when the velocity of the airflow is greater than a threshold value, the functional component to be supplied from the supplier to the airflow.

Brief Description of Drawings

[0009] FIG. 1 illustrates a schematic configuration for an airflow control system according to a first embodiment;

FIG. 2 is an exploded perspective view of an air blower included in the airflow control system;

FIG. 3A is a plan view of a fan included in the air blower of the airflow control system;

FIG. 3B is a plan view of a first rectifier included in the air blower of the airflow control system;

FIG. 3C is a plan view of a second rectifier included in the air blower of the airflow control system;

FIG. 4 is a perspective view of the airflow control system;

FIG. 5A shows the distribution of flow velocities in the air blower of the airflow control system;

FIG. 5B shows the distribution of flow velocities in an air blower included in an airflow control system according to a comparative example;

FIG. 6 illustrates a control method according to the first embodiment;

FIG. 7 illustrates a schematic configuration for an airflow control system according to a second embodiment;

FIG. 8 illustrates a control method according to the second embodiment;

FIG. 9 illustrates a schematic configuration for an airflow control system according to a third embodiment; and

FIG. 10 illustrates a schematic configuration for an airflow control system according to a fourth embodiment.

Description of Embodiments

[0010] The drawings to be referred to in the following description of first to fourth embodiments are all schematic representations. Thus, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio.

[0011] (First embodiment)

An airflow control system 100 and control method according to a first embodiment will now be described with reference to FIGS. 1–6.

[0012] (1) Overview

The airflow control system 100 may be used, for example, in space zoning at a facility. As used herein, the “space zoning” refers to air zoning, which means creating an air environment in a particular area within a target space without putting any physical wall such as a building wall or a partition.

[0013] As shown in FIG. 1, the airflow control system 100 includes an air blower 1, a supplier 7, and a control unit 8. The air blower 1 has an outlet port 24, from which an airflow with a degree of straightness is allowed to blow out. The air blower 1 may adjust the velocity of the airflow blowing out from the outlet port 24. The supplier 7 may supply the airflow blowing out from the outlet port 24 with a functional component to be eventually emitted into the air. The control unit 8 controls the air blower 1 and the supplier 7.

[0014] The airflow (air) blowing out from the outlet port 24 of the air blower 1 in the airflow control system 100 into a target space is a jet and a directional airflow with a degree of straightness. The airflow is a stream of the air. The facility may be an office building, for example. The target space may be, for example, a non-territorial office (which is called a “free-address office” in Japan) in the office building. However, the target space does not have to be a non-territorial office. Alternatively, the target space may also be a space such as an assembly room.

[0015] Examples of the facilities include not only office buildings but also hotels, hospitals, educational institutions, single-family dwelling houses, multi-family dwelling houses (including dwelling units and common areas), stores, commercial facilities, art museums, and museums. Optionally, the facility does not have to be a building alone but may also be a premise with the building. Examples of such facilities include factories, public parks, amusement facilities, theme

parks, airports, railway stations, and domed ballparks.

[0016] (2) Details

As shown in FIG. 1, the airflow control system 100 includes the air blower 1, the supplier 7, and the control unit 8.

[0017] As shown in FIG. 4, the airflow control system 100 may be installed onto, for example, a wiring duct 13 mounted on the ceiling. The airflow control system 100 includes an installer 14, an arm 15, and a coupler 16. The installer 14 is slidably attached onto the wiring duct 13. The arm 15 has a first end 151 and a second end 152. In this arm 15, the first end 151 of the arm 15 is coupled to the installer 14. The coupler 16 couples the second end 152 of the arm 15 to a cylindrical member 2 of the air blower 1. Attaching the installer 14 onto the wiring duct 13 electrically connects the airflow control system 100 to an AC power supply connected to the wiring duct 13. As shown in FIG. 1, the airflow control system 100 further includes a first power supply circuit 91, a first driver circuit 101, a second power supply circuit 92, and a second driver circuit 102. The first power supply circuit 91 converts, for example, an AC voltage supplied from the AC power supply into a first DC voltage and outputs the first DC voltage. The first driver circuit 101 receives the first DC voltage supplied from the first power supply circuit 91 to drive a motor 36 of a fan 3 of the air blower 1. The second power supply circuit 92 converts, for example, the AC voltage supplied from the AC power supply into a second DC voltage and outputs the second DC voltage. The second driver circuit 102 receives the second DC voltage supplied from the second power supply circuit 92 to drive the supplier 7. The first power supply circuit 91, the first driver circuit 101, the second power supply circuit 92, the second driver circuit 102, and the control unit 8 are housed in the housing of the installer 14 (refer to FIG. 4). The arm 15 (refer to FIG. 4) and the coupler 16 (refer to FIG. 4) each have a space into which a part of a first electric wire 111 that connects the first driver circuit 101 to the motor 36 and a part of a second electric wire 112 that connects the second driver circuit 102 to the supplier 7 may be passed.

[0018] The air blower 1 may adjust the velocity of the airflow blowing out from the outlet port 24.

[0019] As shown in FIGS. 1 and 2, the air blower 1 includes the cylindrical member 2, the fan 3, a first rectifier 4, and a second rectifier 5. The air blower 1 may control the velocity of the airflow blowing out from the outlet port 24 by adjusting the number of revolutions of the fan 3. The number of revolutions of the fan 3 varies as the magnitude of the voltage supplied from the first driver circuit 101 to the motor 36 changes. The first driver circuit 101 is controlled by the control unit 8 to change the magnitude of the voltage supplied to the motor 36.

[0020] The cylindrical member 2 may have, for example, a circular cylindrical shape. The cylindrical member 2 has an inlet port 23, through which a gas is introduced, at a first end 21 thereof and has the outlet port 24 at a second end 22 thereof. The fan 3 is disposed inside the cylindrical member 2. The first rectifier 4 is located, in an axial direction D3 of the fan 3, between the fan 3 and the outlet port 24. The first rectifier 4 changes the flowing direction of an airflow F1 (refer to FIG. 3A) swirling. The second rectifier 5 is located, in the axial direction D3 of the fan 3, between the first rectifier 4 and the outlet port 24. The second rectifier 5 unifies the flowing directions of the airflows into a direction aligned with the axial direction D3 of the fan 3. The first rectifier 4 includes a cylindrical portion 41 having a circular cylindrical shape and a plurality of fins (stator vanes) 42. Each of the plurality of fins 42 has an arc shape (refer to FIG. 3B) when viewed in the axial direction D3 of the fan 3. The plurality of fins 42 protrude from the inner circumferential surface 413 of the cylindrical portion 41 toward the center axis 40 of the cylindrical portion 41 and are arranged side by side along the inner circumference of the cylindrical portion 41 as shown in FIG. 3B. The second rectifier 5 has a plurality of flow channels 55 aligned with the axial direction D3 of the fan 3 as shown in FIGS. 1, 2, and 3C.

[0021] As shown in FIGS. 1, 2, and 4, the cylindrical member 2 has a circular cylindrical shape. The cylindrical member 2 has the first end 21 and the second end 22. The cylindrical member 2 has the inlet port 23 for a gas at the first end 21 and has the outlet port 24 for the gas at the second end 22. A material for the cylindrical member 2 may be, but does not have to be, a metal or a resin, for example.

[0022] The fan 3 (refer to FIGS. 1–3) lets the air flowing in the cylindrical member 2 through the inlet port 23 thereof blow toward the outlet port 24 of the cylindrical member 2. The fan 3 is an electric axial-flow fan rotatable around the center axis 30 of rotation of a rotator (hub) 31 included in the fan 3. The fan 3 may move the air flowing into a fan housing 33 while helically rotating the air around the rotator 31 to cause the air to flow to a downstream point. As used herein, the “downstream point” refers to a downstream point when viewed in the direction in which the air flows.

[0023] The fan 3 is disposed inside the cylindrical member 2. The fan 3 is disposed closer to the first end 21 of the cylindrical member 2 rather than to the second end 22 of the cylindrical member 2 in the axial direction of the cylindrical member 2. In the axial direction of the cylindrical member 2, the distance from the fan 3 to the inlet port 23 is shorter than the distance from the fan 3 to the outlet port 24.

[0024] The fan 3 includes the rotator 31, a plurality of (e.g., four) blades (rotary vanes) 32, the

fan housing 33, the motor 36, a motor attachment, and a plurality of (e.g., three) beams. A material for the rotator 31, the plurality of blades 32, and the fan housing 33 of the fan 3 may be, for example, a resin or a metal.

[0025] The rotator 31 is rotatable around the center axis 30 of rotation. When viewed in the axial direction D3 of the fan 3, the outer edge of the rotator 31 has a circular shape. The rotator 31 is disposed inside the cylindrical member 2 to be coaxial with the cylindrical member 2. As used herein, the expression “the rotator 31 is disposed to be coaxial with the cylindrical member 2” means that the rotator 31 is arranged such that the center axis 30 of rotation of the rotator 31 is aligned with the center axis 20 of the cylindrical member 2. In the axial direction D3 of the fan 3, the rotator 31 is shorter in length than the cylindrical member 2. The axial direction D3 of the fan 3 is a direction aligned with the center axis 30 of rotation. The rotator 31 has the shape of a bottomed cylinder having a circular cylindrical portion 311 and a bottom wall 312 and is arranged such that the bottom wall 312 faces the inlet port 23 of the cylindrical member 2. The rotator 31 includes a boss 313 protruding away from the inlet port 23 of the cylindrical member 2 from a central portion of the bottom wall 312.

[0026] The plurality of blades 32 are arranged between the rotator 31 and the fan housing 33 and rotate along with the rotator 31. The plurality of blades 32 are connected to the rotator 31 and protrude from an outer circumferential surface 316 of the rotator 31 toward an inner circumferential surface 27 of the cylindrical member 2. When viewed in the axial direction D3 of the fan 3, the plurality of blades 32 radially protrude from the rotator 31. Each of the plurality of blades 32 is arranged such that a gap is left between the blade 32 and the inner circumferential surface 333 of the fan housing 33 when viewed in the axial direction D3 of the fan 3. In other words, the fan 3 has a gap between each of the plurality of blades 32 and the inner circumferential surface 333 of the fan housing 33. The plurality of blades 32 are arranged at regular intervals when viewed in the axial direction D3 of the fan 3. As used herein, the phrase “arranged at regular intervals” refers to not only a situation where the blades 32 are arranged at exactly the same intervals but also a situation where the difference between the intervals and a predefined interval falls within a predetermined tolerance range (e.g., within $\pm 10\%$ of the predefined interval). In each of the plurality of blades 32, a first end 321 (refer to FIG. 3A) thereof facing the inlet port 23 is located forward of a second end 322 (refer to FIG. 3A) thereof facing the outlet port 24 in a rotational direction R1 (refer to FIG. 3A) of the rotator 31 of the fan 3.

[0027] The fan housing 33 houses the rotator 31 and the plurality of blades 32 to make the rotator 31 and the plurality of blades 32 rotatable. The fan housing 33 has a circular cylindrical shape.

The outside diameter of the fan housing 33 is substantially equal to the inside diameter of the cylindrical member 2. In the fan 3, the fan housing 33 may be fixed to the cylindrical member 2, for example.

[0028] The motor 36 drives the rotator 31 in rotation. More specifically, the motor 36 rotates the rotator 31 around the center axis 30 of rotation of the rotator 31. The motor 36 may be, for example, a DC motor. The motor 36 is driven by the first driver circuit 101 described above. The motor 36 includes a motor body 361 and a rotary shaft 362 partially protruding from the motor body 361. In the motor 36, the rotary shaft 362 is coupled to the rotator 31. The rotary shaft 362 of the motor 36 is fixed to the boss 313 of the rotator 31.

[0029] To the motor attachment, the motor body 361 of the motor 36 is attached. When viewed in the axial direction D3 of the fan 3, the motor attachment may be located inside the outer edge of the rotator 31. However, this is only an example and should not be construed as limiting. Alternatively, when viewed in the axial direction D3 of the fan 3, the motor attachment may overlap in its entirety with the entire rotator 31, for example.

[0030] The plurality of (e.g., three) beams connect the motor attachment to the fan housing 33. The plurality of beams are arranged at regular intervals along the outer edge of the motor attachment.

[0031] The first rectifier 4 is located, in the axial direction D3 of the fan 3, between the fan 3 and the outlet port 24. The first rectifier 4 changes the flowing direction of the airflow F1 (refer to FIG. 3A) swirling downstream of the fan 3. More specifically, the first rectifier 4 turns the airflow F1 swirling downstream of the fan 3 into an airflow F2 (refer to FIG. 3B) flowing toward the center of the fan 3. The first rectifier 4 also forms a flow velocity distribution in which the velocity of an airflow in a first region is higher than the velocity of an airflow in a second region downstream of the first rectifier 4 when viewed in the axial direction D3 of the fan 3. As used herein, the “velocity” of the airflow refers to a velocity as measured in the axial direction D3 of the fan 3. The first region herein refers to a region (inner region) located closer to the center axis 20 of the cylindrical member 2 rather than to the inner circumferential surface 27 of the cylindrical member 2. The second region herein refers to a region (outer region) located closer to the inner circumferential surface 27 of the cylindrical member 2 rather than to the center axis 20 of the cylindrical member 2.

[0032] The first rectifier 4 includes a cylindrical portion 41 having a circular cylindrical shape and a plurality of (e.g., twelve) fins 42 as shown in FIGS. 1–3.

[0033] The outside diameter of the cylindrical portion 41 is substantially equal to the inside

diameter of the cylindrical member 2. The inside diameter of the cylindrical portion 41 is substantially equal to the inside diameter of the fan housing 33.

[0034] Each of the plurality of fins 42 has an arc shape when viewed in the axial direction D3 of the fan 3. The plurality of fins 42 protrude from the inner circumferential surface 413 of the cylindrical portion 41 toward the center axis 40 of the cylindrical portion 41 and are arranged side by side along the inner circumference of the cylindrical portion 41. Each of the plurality of fins 42 has a first end 421, facing the inlet port 23 in the axial direction D3 of the fan 3, and a second end 422, facing the outlet port 24 in the axial direction D3 of the fan 3.

[0035] The plurality of fins 42 are arranged between the inner circumferential surface 413 of the cylindrical portion 41 and the center axis of the cylindrical portion 41 to be parallel to the axial direction D3 of the fan 3. In each of the plurality of fins 42, the first end 421 and the second end 422 thereof overlap with each other when viewed in the axial direction D3 of the fan 3.

[0036] The respective ends, adjacent to the cylindrical portion 41, of the plurality of fins 42 are arranged at regular intervals along the inner circumference of the cylindrical portion 41. As used herein, the phrase “arranged at regular intervals” refers to not only a situation where the respective ends of the fins 42 are arranged at exactly the same intervals but also a situation where the difference between the intervals and a predefined interval falls within a predetermined tolerance range (e.g., within $\pm 10\%$ of the predefined interval). The first rectifier 4 has a plurality of (e.g., twelve) flow channels 45, each of which is surrounded with two adjacent fins 42 out of the plurality of fins 42 and the cylindrical portion 41. When viewed in the axial direction D3 of the fan 3, the width, measured along the inner circumference of the cylindrical portion 41, of each flow channel 45 narrows from the inner circumferential surface 413 of the cylindrical portion 41 toward the center axis 40 of the cylindrical portion 41.

[0037] When measured in the axial direction D3 of the fan 3, the length of each of the plurality of fins 42 may be equal to the length of the cylindrical portion 41. However, the length of each of the plurality of fins 42 does not have to be equal to the length of the cylindrical portion 41 but may be longer or shorter than the length of the cylindrical portion 41, whichever is appropriate.

[0038] Each of the plurality of fins 42 has a first surface 43 intersecting with the inner circumference of the cylindrical member 2 and a second surface 44 intersecting with the inner circumference of the cylindrical member 2 and located opposite from the first surface 43 as shown in FIG. 3B. The first surface 43 is a surface located backward of the second surface 44 in the rotational direction R1 of the rotator 31 (refer to FIG. 3A). The second surface 44 is a surface located forward of the first surface 43 in the rotational direction R1 of the rotator 31. The first

surface 43 is a curved concave surface. The second surface 44 is a curved convex surface.

[0039] A material for the first rectifier 4 may be, but does not have to be, a metal, and may also be a resin.

[0040] The second rectifier 5 is located, in the axial direction D3 of the fan 3, between the first rectifier 4 and the outlet port 24 of the cylindrical member 2. The second rectifier 5 adjusts, downstream of the first rectifier 4, the flow velocity distribution of the airflow coming from the first rectifier 4. The second rectifier 5 has a plurality of flow channels 55 aligned with the axial direction D3 of the fan 3. Each of the plurality of flow channels 55 has an inlet 551 facing the first rectifier 4 and an outlet 552 facing the outlet port 24 of the cylindrical member 2. In each of the plurality of flow channels 55, the inlet 551 and the outlet 552 have the same shape. In each of the plurality of flow channels 55, the inlet 551 and the outlet 552 have the same size. The second rectifier 5 includes a rectifying grid 50 and a cylindrical portion 51 surrounding the rectifying grid 50 and having a circular cylindrical shape. The rectifying grid 50 includes a plurality of partitions 56 partitioning, from each other, any two adjacent flow channels 55 out of the plurality of flow channels 55. The plurality of partitions 56 are arranged in the axial direction D3 of the fan 3. The rectifying grid 50 has the shape of a honeycomb grid. In this embodiment, when viewed in the axial direction D3 of the fan 3, the inlet 551 and outlet 552 of each of the plurality of flow channels 55 each have a regular hexagonal shape. In other words, each of the plurality of flow channels 55 has a hexagonal prism shape.

[0041] The outside diameter of the cylindrical portion 51 is substantially equal to the inside diameter of the cylindrical member 2. The second rectifier 5 is arranged in the cylindrical member 2 such that the center axis of the cylindrical portion 51 is aligned with the center axis 20 of the cylindrical member 2.

[0042] A material for the second rectifier 5 may be, but does not have to be, a resin, and may also be a metal, for example.

[0043] The supplier 7 may supply a functional component, which will eventually be emitted into the air, to the airflow that is going to blow out from the outlet port 24. More specifically, the supplier 7 includes a generator 71 and a functional component carrying flow channel 72. The generator 71 generates, for example, mist containing the functional component. The functional component carrying flow channel 72 communicates with the space between the first rectifier 4 and the outlet port 24 inside the cylindrical member 2. Examples of the functional components include a deodorization component, a fragrance component, a disinfection component, a sterilization component, a cosmetic component, and a pharmaceutical component. The supplier

7 is configured to supply the functional component from a functional material containing the functional component. Examples of such a functional material containing the functional component include a solution containing the functional component.

[0044] The generator 71 includes: an atomizer for atomizing, for example, a solution containing the functional component; and an energy supply device for giving energy to the solution to allow the atomizer to atomize the solution. The energy supply device may be, but does not have to be, an ultrasonic vibrator, for example, and may also be a surface acoustic wave (SAW) device, for example. The generator 71 is driven by the second driver circuit 102.

[0045] In the air blower 1, the cylindrical member 2 has a communication hole 25 which penetrates through the cylindrical member 2 between the first end 21 and the second end 22 thereof and extends in a direction intersecting with the axial direction of the cylindrical member 2. The functional component carrying flow channel 72 communicates with the outlet port 24 of the cylindrical member 2 via the communication hole 25. The functional component carrying flow channel 72 may be formed by, for example, attaching a flow channel forming member 73 onto the cylindrical member 2. The functional component carrying flow channel 72 is formed between the flow channel forming member 73 and the outer circumferential surface 28 of the cylindrical member 2 and communicates with the space inside the cylindrical member 2 via the communication hole 25 of the cylindrical member 2.

[0046] The supplier 7 has the mist containing the functional component that has been generated by the generator 71, supplied, via the functional component carrying flow channel 72 and the communication hole 25, to the airflow blowing out from the outlet port 24. The supplier 7 may cause the mist containing the functional component to rush into the airflow inside the cylindrical member 2 and thereby have the mist containing the functional component carried inside the cylindrical member 2. Alternatively, the supplier 7 may include a fan that feeds the mist containing the functional component into the cylindrical member 2. The functional component carrying flow channel 72 does not have to be formed out of the flow channel forming member 73. Alternatively, the functional component carrying flow channel 72 may also be implemented as a tubular member which has a first end and a second end and of which the first end is connected to the generator 71 and the second end is disposed inside the cylindrical member 2 through the communication hole 25.

[0047] The control unit 8 controls the air blower 1 and the supplier 7. The control unit 8 controls the fan 3 by controlling the first driver circuit 101. In addition, the control unit 8 also controls the supplier 7 by controlling the second driver circuit 102. Examples of control of the

air blower 1 by the control unit 8 include starting turning the fan 3, stopping turning the fan 3, and controlling the number of revolutions of the fan 3. The control unit 8 may control the velocity of the airflow blowing out from the outlet port 24 of the air blower 1 by adjusting the drive voltage of the (motor 36 of the) fan 3 and thereby controlling the number of revolutions of the fan 3. The number of revolutions of the fan 3 and the volume of the air supplied by the fan 3 vary as the drive voltage changes. Specifically, as the drive voltage increases, the number of revolutions of the fan 3 and the volume of the air supplied by the fan 3 also increase. In the air blower 1, as the number of revolutions of the fan 3 increases, the velocity of the airflow blowing out from the outlet port 24 increases. Examples of the control of the supplier 7 by the control unit 8 also include starting atomizing the solution at the generator 71, stopping atomizing the solution, and controlling the rate of atomizing the solution.

[0048] The control unit 8 may supply the airflow blowing out from the outlet port 24 with the functional component to be eventually emitted into the air by controlling the air blower 1 and the supplier 7. The control unit 8 may also control the timing to supply the airflow blowing out from the outlet port 24 with the functional component to be eventually emitted into the air by controlling the air blower 1 and the supplier 7.

[0049] The control unit 8 includes a computer system. The computer system may include a processor and a memory as principal hardware components thereof. The functions of the control unit 8 may be performed by making the processor execute a program stored in the memory of the computer system. The program may be stored in advance in the memory of the computer system. Alternatively, the program may also be downloaded through a telecommunications line or be distributed after having been recorded in some non-transitory storage medium such as a memory card, an optical disc, or a hard disk drive, any of which is readable for the computer system. The processor of the computer system may be made up of a single or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or a large-scale integrated circuit (LSI). As used herein, the “integrated circuit” such as an IC or an LSI is called by a different name depending on the degree of integration thereof. Examples of the integrated circuits such as an IC or an LSI include integrated circuits called a “system LSI,” a “very-large-scale integrated circuit (VLSI),” and an “ultra-large-scale integrated circuit (ULSI).” Optionally, a field-programmable gate array (FPGA) to be programmed after an LSI has been fabricated or a reconfigurable logic device allowing the connections or circuit sections inside of an LSI to be reconfigured may also be adopted as the processor. Those electronic circuits may be either integrated together on a single chip or distributed on multiple chips, whichever is appropriate. Those multiple chips may be

aggregated together in a single device or distributed in multiple devices without limitation. As used herein, the “computer system” includes a microcontroller including one or more processors and one or more memories. Thus, the microcontroller may also be implemented as a single or a plurality of electronic circuits including a semiconductor integrated circuit or a large-scale integrated circuit.

[0050] (3) Operation of airflow control system

(3.1) Operation of air blower

In the air blower 1, the rotator 31 and the plurality of blades 32 of the fan 3 turn in the predetermined rotational direction R1 (refer to FIG. 3A), thereby causing the air to rush into the fan 3 through the inlet port 23 of the cylindrical member 2. As a result, an airflow F1 (refer to FIG. 3A) swirling along the inner circumferential surface 27 of the cylindrical member 2 is generated inside the cylindrical member 2 downstream of the fan 3 inside the cylindrical member 2. The swirling airflow F1 is a spirally turning, three-dimensional airflow.

[0051] In the air blower 1, the airflow F1 (refer to FIG. 3A) generated downstream of the fan 3 which is swirling, around the inner circumferential surface 27 of the cylindrical member 2, along the inner circumferential surface 27 has its flowing direction changed, by the first rectifier 4, to a direction pointing toward the center axis 40 of the first rectifier 4. More specifically, in the first rectifier 4, the airflow F1 (refer to FIG. 3A) swirling along the inner circumferential surface 27 of the cylindrical member 2 collides against the fins 42, thereby turning the airflow F1 into an airflow F2 (refer to FIG. 3B) flowing toward the center axis 40 of the first rectifier 4. In other words, the first rectifier 4 collects the airflow F1 generated by the fan 3 which is swirling along the inner circumferential surface 27 of the cylindrical member 2 toward the center axis 40 of the first rectifier 4 and thus forms, downstream of the first rectifier 4, a flow velocity distribution in which the velocity of an airflow in the first region is higher than the velocity of an airflow in the second region. In sum, the air blower 1 may have the first rectifier 4 form a velocity distribution in which the velocity of the airflow is relatively high inside and relatively low outside. In this case, the velocity of the airflow is a velocity measured in the axial direction D3 of the fan 3. The first region herein refers to a region (inner region) located closer to the center axis 20 of the cylindrical member 2 rather than to the inner circumferential surface 27 of the cylindrical member 2 between the center axis 20 of the cylindrical member 2 and the inner circumferential surface 27 of the cylindrical member 2. The second region herein refers to a region (outer region) located closer to the inner circumferential surface 27 of the cylindrical member 2 rather than to the center axis 20 of the cylindrical member 2 between the center axis 20 of the cylindrical member 2 and the

inner circumferential surface 27 of the cylindrical member 2.

[0052] In the air blower 1, the second rectifier 5 provided downstream of the first rectifier 4 changes the flowing direction of the airflow coming from the first rectifier 4 into the direction aligned with the axial direction D3 of the fan 3.

[0053] In the air blower 1, an airflow rectified by the second rectifier 5 flows out from the outlet port 24 of the cylindrical member 2.

[0054] In the air blower 1, when the fan 3 is driven, an airflow flowing downstream of the fan 3 is rectified by the first rectifier 4 and the second rectifier 5 to blow out from the outlet port 24 of the cylindrical member 2.

[0055] FIG. 5A shows a flow velocity distribution in the vicinity of the outlet port 24 of the cylindrical member 2 of the air blower 1. FIG. 5A shows the flow velocity distribution in the air blower 1 of the airflow control system 100 according to the first embodiment in a situation where the air volume of the fan 3 is set at 70 m³/h and the structural parameters are set as follows. Meanwhile, FIG. 5B shows a flow velocity distribution in an air blower according to a comparative example including neither the first rectifier 4 nor the second rectifier 5.

<Structure parameters>

- Inside diameter of the cylindrical member 2: 144 mm;
- Number of fins 42 of the first rectifier 4: 12;
- Length of each fin 42 in the axial direction D3 of the fan 3: 50 mm;
- Inlet 551 of each flow channel 55 in the second rectifier 5: regular hexagon having a distance of 8 mm between opposite sides;
- Outlet 552 of each flow channel 55 in the second rectifier 5: regular hexagon having a distance of 8 mm between opposite sides; and
- Length of each flow channel 55 in the second rectifier 5: 30 mm.

FIGS. 5A and 5B each show the flow velocity distribution at a cross section including the center axis 20 of the cylindrical member 2. In FIGS. 5A and 5B, the abscissa indicates the distance as measured from the center axis 20 of the cylindrical member 2, and the ordinate indicates the flow velocity. The abscissa is “positive” on the right of the center axis 20 and “negative (– sign)” on the left of the center axis. These “positive” and “negative (–)” signs are given to distinguish a distance to an arbitrary location on the right of the center axis 20 and a distance to an arbitrary location on the left of the center axis 20 from each other.

[0056] In the air blower according to the comparative example, the flow velocity increases as the

distance from the center of the outlet port 24 increases as shown in FIG. 5B. In contrast, the air blower 1 of the airflow control system 100 according to the first embodiment may provide a flow velocity distribution in which the flow velocity in the inner region of the outlet port 24 is higher than the flow velocity in the outer region of the outlet port 24 as shown in FIG. 5A. The air blower 1 may blow out double jet streams, namely, a first jet stream blowing out from the inner region of the outlet port 24 and a second jet stream blowing out from the outer region of the outlet port 24.

[0057] The air blower 1 may increase the degree of directivity of the airflow (jet stream) blowing out from the outlet port 24 of the cylindrical member 2 and may reduce the diffusion of the airflow. Thus, the air blower 1 may carry the airflow toward a local spot in a particular area within the target space.

[0058] (3.2) Operation of control unit

The control unit 8 performs fluctuation control (refer to FIG. 6) on, for example, the velocity of the airflow blowing out from the outlet port 24 (e.g., the velocity of the first jet stream blowing out from the inner region of the outlet port 24). The control unit 8 allows, when the velocity of the airflow is greater than the threshold value $V1$ (refer to FIG. 6), the functional component to be supplied from the supplier 7 to the airflow. As used herein, “to perform fluctuation control on the velocity of the airflow” means controlling the velocity of the airflow such that the variation in the airflow velocity with time has a fluctuation characteristic. The fluctuation characteristic may be, for example, a $1/f$ fluctuation characteristic. In this embodiment, the phrase means controlling the airflow velocity such that the variation in the airflow velocity has a $1/f$ fluctuation waveform. As used herein, the “ $1/f$ fluctuation” refers to fluctuation that makes the density of a power spectrum inversely proportional to the frequency f . The fluctuation characteristic does not have to be the $1/f$ fluctuation but may also be a $1/f^2$ fluctuation, for example. Alternatively, the fluctuation characteristic does not have to be the irregular fluctuation characteristic (such as the $1/f$ fluctuation or the $1/f^2$ fluctuation) but may also be a regular fluctuation characteristic.

[0059] When allowing the functional component to be supplied from the supplier 7 to the airflow, the control unit 8 allows the functional component to be supplied temporarily (or instantaneously) to the airflow.

[0060] The control unit 8 allows, when the velocity of the airflow blowing out from the outlet port 24 is equal to or less than a second threshold value $V2$ greater than a first threshold value $V1$ as the threshold value $V1$, the functional component to be supplied from the supplier 7 to the

airflow. FIG. 6 shows a time variation in the velocity of the airflow blowing out from the outlet port 24. In FIG. 6, the abscissa indicates the time, and the ordinate indicates the airflow velocity. The control unit 8 performs fluctuation control on the airflow velocity to cause the airflow velocity to vary within a range equal to or greater than a first velocity VL and equal to or less than a second velocity VH. The second velocity VH is greater than the first velocity VL. The first velocity VL may be 0.05 m/sec, for example. The second velocity VH may be 1.5 m/sec, for example. The first threshold value V1 is determined to allow the functional component on the airflow to reach the target space and may be 1.0 m/sec, for example. The second threshold value V2 may be 1.6 m/sec, for example. These values of the first threshold value V1 and the second threshold value V2 are only examples and should not be construed as limiting.

[0061] In addition, the control unit 8 has the functional component supplied from the supplier 7 to the airflow at a point in time t3 when the airflow velocity is greater than the first threshold value V1 and equal to or less than the second threshold value V2. The point in time t3 is later than a point in time t2 when a predetermined amount of time T1 has passed since a point in time t1 when the functional component started to be supplied. Even if the airflow velocity becomes greater than the first threshold value V1 and equal to or less than the second threshold value V2 before the predetermined amount of time T1 passes since the point in time t1, the control unit 8 prevents the functional component from being supplied from the supplier 7 to the airflow. The predetermined amount of time T1 may be, but does not have to be, 30 seconds.

[0062] (4) Control method

A control method according to the first embodiment is a method for controlling a system including the air blower 1 and the supplier 7.

[0063] The control method according to the first embodiment is performed by the operation of the control unit 8. This control method includes: performing fluctuation control (refer to FIG. 6) on the velocity of the airflow blowing out from the outlet port 24; and allowing, when the velocity of the airflow is greater than the threshold value V1 (refer to FIG. 6), the functional component to be supplied from the supplier 7 to the airflow. More specifically, the control method includes performing the fluctuation control on the velocity of the airflow blowing out from the outlet port 24 by controlling the number of revolutions of the fan 3 of the air blower 1, for example.

[0064] In addition, the control method according to the first embodiment includes allowing, when the velocity of the airflow blowing out from the outlet port 24 is equal to or less than the second threshold value V2 greater than the first threshold value V1 as the threshold value V1, the functional component to be supplied from the supplier 7 to the airflow. For example, this control

method includes allowing, when the drive voltage of the motor 36 is greater than a voltage value corresponding to the threshold value V1 and equal to or less than a voltage value corresponding to the second threshold value V2, the functional component to be supplied from the supplier 7 to the airflow. Thus, the control method according to the first embodiment may reduce, for example, the amount of the functional component used by the supplier 7. Consequently, the control method according to the first embodiment may reduce either the frequency at which a container holding the functional material at the generator 71 of the supplier 7 needs to be replaced or the frequency at which the container needs to be refilled with the functional material.

[0065] The control method according to the first embodiment is performed by causing a computer system to execute a program. The program is a (computer) program designed to cause the computer system to perform the control method.

[0066] (5) Advantages

A control method according to the first embodiment is designed to control a system including an air blower 1 and a supplier 7. The air blower 1 has an outlet port 24, from which an airflow with a degree of straightness is allowed to blow out. The air blower 1 may adjust the velocity of the airflow blowing out from the outlet port 24. The supplier 7 may supply the airflow blowing out from the outlet port 24 with a functional component to be eventually emitted into the air. The control method includes: performing fluctuation control on the velocity of the airflow blowing out from the outlet port 24; and allowing, when the velocity of the airflow is greater than a threshold value V1, the functional component to be supplied from the supplier 7 to the airflow. This control method may contribute to increasing the degree of comfort. More specifically, this control method may contribute to increasing the degree of comfort of a person present within the reachable range of the airflow blowing out from the air blower 1. According to this control method, fluctuation control is performed on the velocity of the airflow blowing out from the outlet port 24, thus reducing the chances of the person present within the airflow's reachable range feeling chilly or uncomfortable. In addition, when the velocity of the airflow is greater than the threshold value V1, the functional component is supplied from the supplier 7 to the airflow, thus allowing the functional component to reach the person present within the airflow's reachable range.

[0067] In addition, the control method according to the first embodiment includes allowing, when the velocity of the airflow blowing out from the outlet port 24 is equal to or less than a second threshold value V2 greater than a first threshold value V1 as the threshold value V1, the functional component to be supplied from the supplier 7 to the airflow. Thus, the control method according to the first embodiment may reduce either the frequency at which a container holding the functional

material at the supplier 7 needs to be replaced or the frequency at which the container needs to be refilled with the functional material.

[0068] A program according to the first embodiment is a program (computer program) designed to cause a computer system to perform the control method described above. Such a program, as well as the control method described above, may also contribute to increasing the degree of comfort.

[0069] An airflow control system 100 according to the first embodiment includes an air blower 1, a supplier 7, and a control unit 8. The air blower 1 has an outlet port 24, from which an airflow with a degree of straightness is allowed to blow out. The air blower 1 may adjust the velocity of the airflow blowing out from the outlet port 24. The supplier 7 may supply the airflow blowing out from the outlet port 24 with a functional component to be eventually emitted into the air. The control unit 8 controls the air blower 1 and the supplier 7. The control unit 8 controls the air blower 1 to perform fluctuation control on the velocity of the airflow blowing out from the outlet port 24. The control unit 8 controls the supplier 7 to allow, when the velocity of the airflow is greater than a threshold value, the functional component to be supplied from the supplier 7 to the airflow. Thus, the airflow control system 100 according to the first embodiment may contribute to increasing the degree of comfort.

[0070] The airflow control system 100 includes the air blower 1 having the outlet port 24, from which an airflow with a degree of straightness is allowed to blow out. This may reduce the diffusion of the airflow, and therefore, may reduce the diffusion of the airflow containing the functional component. The airflow control system 100 includes the supplier 7 and the control unit 8, thus allowing the airflow blowing out into the target space at a facility to contain the functional component. In addition, the airflow control system 100 may also reduce the diffusion of the airflow containing the functional component in the target space. As used herein, “to reduce the diffusion of the airflow containing the functional component” means increasing the degree of straightness of the airflow containing the functional component and thereby increasing the directivity thereof. The airflow control system 100 according to the first embodiment may reduce the chances of causing a decrease in the concentration of the functional component before the functional component reaches the target space to which the functional component should be supplied. Consequently, the airflow control system 100 according to the first embodiment may enhance the effect produced by the functional component.

[0071] (Second embodiment)

Next, an airflow control system 100a and control method according to a second

embodiment will be described with reference to FIGS. 7 and 8. The airflow control system 100a according to the second embodiment includes a supplier 7a instead of the supplier 7 of the airflow control system 100 according to the first embodiment, which is a difference from the airflow control system 100 according to the first embodiment. In the following description, any constituent element of the airflow control system 100a according to this second embodiment, having the same function as a counterpart of the airflow control system 100 according to the first embodiment described above, will be designated by the same reference numeral as that counterpart's, and description thereof will be omitted herein.

[0072] The supplier 7a is configured to generate the functional component based on a component included in the air and supply the functional component thus generated. The functional component may be, for example, charged water particles including OH radicals. The generator 71a may include, for example, an electrostatic atomizer for generating charged water particles including OH radicals. The charged water particles are fine particle ions of a nanometer scale. The electrostatic atomizer may generate fine particle ions having a particle size falling within the range from 5 nm to 20 nm by applying a high voltage to water in the air, for example. In the charged water particles, the OH radicals readily act on various substances. The supplier 7a includes a functional component carrying flow channel 74 instead of the functional component carrying flow channel 72 of the supplier 7. The functional component carrying flow channel 74 may be, for example, a tubular member having a first end and second end. The first end of the functional component carrying flow channel 74 is connected to the generator 71a and the second end thereof is disposed inside the cylindrical member 2 through the communication hole 25.

[0073] In the airflow control system 100a according to the second embodiment, the control unit 8 causes, when performing fluctuation control on the velocity of the airflow blowing out from the outlet port 24, the velocity of the airflow to vary within a range equal to or greater than a first velocity VL and equal to or less than a second velocity VH, and allows, when the velocity of the airflow is greater than a threshold value V1, the functional component to be supplied from the supplier 7a to the airflow. In the airflow control system 100a according to the second embodiment, the threshold value V1 may be, for example, a velocity (e.g., 0.04 m/sec) less than 0.05 m/sec that is the first velocity VL.

[0074] The control method according to the second embodiment, as well as the control method according to the first embodiment, includes performing fluctuation control on the velocity of the airflow blowing out from the outlet port 24 and allowing, when the velocity of the airflow is greater than the threshold value V1, the functional component to be supplied from the supplier 7a to the

airflow. This contributes to increasing the degree of comfort.

[0075] The control method according to the second embodiment includes: causing, when performing the fluctuation control on the velocity of the airflow blowing out from the outlet port 24, the velocity of the airflow to vary within the range equal to or greater than the first velocity VL and equal to or less than the second velocity VH, and allowing, when the velocity of the airflow is greater than the threshold value V1, the functional component to be supplied from the supplier 7a to the airflow. Thus, the control method according to the second embodiment allows the functional component to be supplied continuously in a period in which the airflow blowing out from the outlet port 24 of the air blower 1 is varying within the range equal to or greater than the first velocity VL and equal to or less than the second velocity VH. More specifically, this control method includes controlling the velocity of the airflow blowing out from the outlet port 24 by, for example, controlling the number of revolutions of the fan 3 of the air blower 1.

[0076] In the control method according to the second embodiment, the threshold value V1 does not have to be a value less than the first velocity VL but may also be, for example, a value equal to the first velocity VL.

[0077] (Third embodiment)

Next, an airflow control system 100b according to a third embodiment will be described with reference to FIG. 9. In the following description, any constituent element of the airflow control system 100b according to this third embodiment, having the same function as a counterpart of the airflow control system 100 according to the first embodiment described above, will be designated by the same reference numeral as that counterpart's, and description thereof will be omitted herein.

[0078] The airflow control system 100b may be applied to, for example, an environmental control system 200 for controlling the space environment of a facility such as an office as shown in FIG. 9.

[0079] As shown in FIG. 9, the environmental control system 200 includes a plurality of air conditioners 201, a server 202, and a plurality of airflow control systems 100b. The server 202 may communicate with the plurality of air conditioners 201 via a communications network 500. The server 202 may also communicate with the plurality of airflow control systems 100b via a communications network 600. The communications networks 500, 600 may include the Internet. The communications networks 500, 600 may be not only networks compliant with a single communications protocol but also a plurality of networks compliant with multiple different communications protocols. The communications protocol may be, for example, a

communications protocol compliant with the Ethernet (R) standard or a communications protocol compliant with the Wi-Fi (R) standard, whichever is appropriate. The communications network may include data communications devices such as a repeater hub, a switching hub, a bridge, a gateway, and a router. Alternatively, the communications networks 500, 600 may also be a power line communications network that uses the power line.

[0080] The plurality of air conditioners 201 may be arranged, for example, on the ceiling of the office. The plurality of air conditioners 201 have mutually different pieces of identification information. The identification information of each of the air conditioners 201 is stored in the air conditioner's 201 own storage unit 215. The storage unit 215 may be, for example, a nonvolatile memory such as an electrically erasable programmable read-only memory (EEPROM).

[0081] Each of the plurality of air conditioners 201 includes: a flap 211 for changing the blowing direction of the air; a fan 212 for adjusting the flow velocity of the airstream to blow out; a communications unit 213 for communicating with the server 202; a control unit 214 for controlling the flap 211 and the fan 212 in accordance with instruction information that the control unit 214 has received from the server 202 via the communications unit 213; and a storage unit 215. The control unit 214 of each of the plurality of air conditioners 201 controls, in accordance with the instruction given by the server 202, for example, the flow velocity and blowing direction of the airstream blowing out from the air conditioner 201.

[0082] The plurality of airflow control systems 100b may be connected, for example, to a wiring duct on the ceiling of the office where the plurality of air conditioners 201 are installed. The plurality of airflow control systems 100b have mutually different pieces of identification information. The identification information of each of the plurality of airflow control systems 100b is stored in, for example, a nonvolatile memory included in the control unit 8. Each airflow control system 100b includes a communications unit 9 for communicating with the server 202. The control unit 8 of each of the plurality of airflow control systems 100b controls the air blower 1 and the supplier 7 in accordance with the information that the control unit 8 has received from the server 202 via the communications unit 9 (such as instruction information or information about the operation of the air conditioner 201), for example.

[0083] The server 202 includes: a control unit 220 for controlling the plurality of air conditioners 201 and the plurality of airflow control systems 100b; a first communications unit 221 for communicating with the plurality of air conditioners 201; a second communications unit 222 for communicating with the plurality of airflow control systems 100b; and a storage unit 223.

[0084] The server 202 makes the storage unit 223 store the identification information and

location information of the plurality of air conditioners 201 and the identification information and location information of the plurality of airflow control systems 100b.

[0085] The first communications unit 221 is a communications interface. Particularly, the first communications unit 221 is a communications interface which may be connected to the communications network and has the capability of establishing a communication via the communications network 500. This allows the server 202 to communicate with the plurality of air conditioners 201 over the communications network 500. A signal that the first communications unit 221 receives from each of the plurality of air conditioners 201 may include, for example, the identification information of the air conditioner 201, information about the flow velocity of the airstream blowing out from the air conditioner 201, and information about the blowing direction of the airstream blowing out from the air conditioner 201.

[0086] The second communications unit 222 is a communications interface. Particularly, the second communications unit 222 is a communications interface which may be connected to the communications network 600 and has the capability of establishing a communication via the communications network 600. More particularly, the second communications unit 222 may communicate with the plurality of airflow control systems 100b via the communications network 600. The communications protocol of the second communications unit 222 may be selected from various known wired communications protocols and wireless communications protocols.

[0087] The storage unit 223 is an information storage device. The storage unit 223 may be, for example, a read-only memory (ROM), a random-access memory (RAM), or an EEPROM. The storage unit 223 has a storage area for storing determination information for use to determine whether the blowing direction of the airstream blowing out from the air conditioner 201 is aligned with the airflow blowing direction of the airflow control system 100b. Examples of the determination information include information about the air-conditioning area, information about the respective air conditioners 201, and information about the respective airflow control systems 100b. The information about the air-conditioning area is a piece of information for use to determine the dimensions, shape, and other parameters of the air-conditioning area. The information about the respective air conditioners 201 includes information for use to identify the air conditioners 201 (i.e., identification information) and location information of the air conditioners 201. The location information of the air conditioners 201 may be, for example, sets of coordinates indicating the respective locations of the air conditioners 201 in the facility such as an office. The information about the respective airflow control systems 100b includes information for use to identify the airflow control systems 100b (identification information) and

the location information of the airflow control systems 100b. The location information of the airflow control systems 100b may be, for example, sets of coordinates indicating the respective locations of the airflow control systems 100b in the facility such as an office.

[0088] The control unit 220 is configured to perform overall control on the server 202. That is to say, the control unit 220 is configured to control the first communications unit 221, the second communications unit 222, and the storage unit 223. The control unit 220 may be implemented as, for example, a computer system including one or more processors (microprocessors) and one or more memories. The functions of the control unit 220 are performed by making the one or more processors execute a program (applications) stored in the one or more memories. In this embodiment, the program is stored in advance in the memory of the control unit 220. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored in a non-transitory storage medium such as a memory card.

[0089] The control unit 8 of each airflow control system 100b controls the supplier 7 in accordance with the operation information of its associated air conditioner 201 that the control unit 8 has received from the control unit 220 of the server 202. The operation information of the air conditioner 201 may include information about the flow velocity of the airstream blowing out from the air conditioner 201 and information about the blowing direction of the airstream. The control unit 8 prevents, if the flow velocity of the airstream blowing out from the air conditioner 201 for performing air conditioning on the air-conditioning area, including the space to which the airflow is supplied from the air blower 1, is greater than the second threshold value V2, the functional component from being supplied from the supplier 7 to the airflow. This allows the airflow control system 100b to reduce the chances of the functional component being diffused by being affected by the airstream blowing out from the air conditioner 201.

[0090] The control method according to the third embodiment includes preventing, if the flow velocity of the airstream blowing out from the air conditioner 201 for performing air conditioning on the air-conditioning area, including the space to which the airflow is supplied from the air blower 1, is greater than the second threshold value V2, the functional component from being supplied from the supplier 7 to the airflow. This allows the control method according to the third embodiment to reduce the chances of the functional component being diffused by being affected by the airstream blowing out from the air conditioner 201.

[0091] The control method according to the third embodiment further includes preventing, when deciding that the blowing direction of the airstream blowing out from the air conditioner 201 is

aligned with the direction in which the airflow is being supplied from the air blower 1 toward the space, the functional component from being supplied from the supplier 7 to the airflow. This allows the control method according to the third embodiment to reduce the chances of the functional component being diffused by being affected by the airstream blowing out from the air conditioner 201. Note that this control method includes determining, based on the information provided by the server 202, for example, whether the blowing direction of the airstream blowing out from the air conditioner 201 is aligned with the direction in which the airflow is being supplied from the air blower 1 toward the space. This decision may also be made by the control unit 220 of the server 202.

[0092] (Fourth embodiment)

An airflow control system 100c according to a fourth embodiment will now be described with reference to FIG. 10. In the airflow control system 100c according to the fourth embodiment, the control unit 8 controls the supplier 7 based on an evaluation value indicating the magnitude of movement representing a person's movement which is provided by a detection unit 11, which is a difference from the airflow control system 100 according to the first embodiment. The airflow control system 100c further includes an acquisition unit 10 for acquiring the evaluation value provided by the detection unit 11. The control unit 8 controls the supplier 7 based on the evaluation value acquired by the acquisition unit 10. The acquisition unit 10 may be, for example, a communications interface. In the following description, any constituent element of the airflow control system 100c according to this fourth embodiment, having the same function as a counterpart of the airflow control system 100 according to the first embodiment described above, will be designated by the same reference numeral as that counterpart's, and description thereof will be omitted herein.

[0093] The detection unit 11 detects the presence of any person within a detection area, including the space to which the airflow is supplied from the air blower 1, to output an evaluation value indicating the magnitude of movement representing the person's movement (e.g., the moving velocity). The detection unit 11 includes, for example, an infrared image sensor which is mounted on the ceiling of an office where the air blower 1 is installed to detect the presence of a person within the detection area in the office. The infrared image sensor includes: an infrared sensor including a plurality of infrared detectors that absorb an infrared ray coming from the person present within the detection area; and a processing unit for processing the output signal of the infrared sensor to generate infrared image data continuously. Each infrared detector may include, for example, a thermopile. The processing unit detects the presence of a person based on the

infrared image data to obtain an evaluation value representing the person's movement. The processing unit detects the presence of a person in a predetermined area, including the reachable range of the airflow blowing out from the air blower 1, within the detection area to obtain the evaluation value representing the person's movement. The predetermined area does not have to be smaller than the detection area but may also be the same as the detection area. The processing unit calculates, with respect to each person present in the predetermined area, an average value of his or her moving velocity per unit time and calculates the evaluation value by adding the average values together. Thus, as the average value of the moving velocity of the person moving within the predetermined area increases, the evaluation value also increases accordingly. In addition, as the number of persons moving within the predetermined area increases, the evaluation value also increases accordingly. The processing unit includes, as a principal constituent element thereof, a computer such as a microcomputer. The processing unit performs appropriate processing by making a processor of the computer execute a program stored in a memory of the computer. The program may be stored in advance in the memory. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored in a storage medium such as a memory card.

[0094] In the airflow control system 100c according to the fourth embodiment, the control unit 8 prevents, if the evaluation value provided by the detection unit 11, which detects the presence of a person within a detection area including the space to which the airflow is supplied from the air blower 1 and outputs the evaluation value representing the person's movement, is greater than a prescribed value, the functional component from being supplied from the supplier 7 to the airflow. This allows the airflow control system 100c according to the fourth embodiment to reduce the chances of the functional component being diffused by the person's movement.

[0095] The control method according to the fourth embodiment includes preventing, if the evaluation value provided by the detection unit 11, which detects the presence of a person within a detection area including the space to which the airflow is supplied from the air blower 1 and outputs the evaluation value representing the person's movement, is greater than the prescribed value, the functional component from being supplied from the supplier 7 to the airflow. This allows the control method according to the fourth embodiment to reduce the chances of the functional component being diffused by the person's movement.

[0096] (Variations)

Note that the first to fourth embodiments described above are only exemplary ones of various embodiments of the present disclosure and should not be construed as limiting. Rather,

the first to fourth embodiments may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure. Optionally, mutually different constituent elements of multiple different ones of those embodiments may be adopted in combination as appropriate.

[0097] For example, the control method according to the first embodiment may have, as the control modes for performing fluctuation control on the velocity of the airflow blowing out from the outlet port 24, a first control mode in which the functional component is allowed to be supplied from the supplier 7 to the airflow when the velocity of the airflow is greater than a threshold value $V1$; and a second control mode in which the functional component is allowed to be supplied to the airflow when the velocity of the airflow is equal to or less than a predetermined value smaller than the threshold value $V1$. In that case, the control method may include controlling the supplier 7 in either the first control mode or the second control mode in accordance with an operating command entered through an operating unit to be operated by a person (such as a remote controller or an operating switch). Alternatively, the control method may include controlling the supplier 7 in either the first control mode or the second control mode according to the number of persons detected by a human presence sensor. The human detection sensor detects the presence of a person within a detection area including the space to which the airflow is supplied from the air blower 1. In a situation where the control method includes controlling the supplier 7 according to the number of persons detected by the human detection sensor, this control method allows, when the number of persons detected is one, the supplier 7 to be controlled in the first control mode and allows, when the number of persons detected is equal to or greater than two, the supplier 7 to be controlled in the second control mode. This control method may make, when the number of persons detected is one, the range in which the functional component is carried narrower than when the number of persons detected is equal to or greater than two. In other words, this control method may make, when the number of persons detected is equal to or greater than two, the range in which the functional component is carried broader than when the number of persons detected is one.

[0098] Optionally, the control method may include controlling the supplier 7 in accordance with, for example, the output of an artificial intelligence (AI) speaker which accepts human speech input.

[0099] Alternatively, the control unit 8 of the airflow control system 100 according to the first embodiment may also control the fan 3 and the supplier 7 in accordance with, for example, information acquired from a sensor. Examples of the sensors include an image sensor, a human detection sensor (motion sensor), an ultrasonic sensor, a Doppler sensor, a radio wave sensor, a

biometric information sensor, a behavior sensor, and an environmental sensor. Any image sensor may be used as long as the image sensor may provide information about a target object (such as a human being) present in the target space. Examples of the image sensor include an infrared image sensor, a complementary metal-oxide semiconductor (CMOS) image sensor, a charge-coupled device (CCD) image sensor, and a distance image sensor representing the distance as a pixel value. Examples of the biometric information sensors include a wearable terminal for measuring at least the heartbeat. Examples of such a wearable terminal for measuring at least the heartbeat include a wristband- or watch-type wearable terminal that a person who goes into, and comes out of, the target space is supposed to wear on the wrist. The behavior sensor may be implemented as, for example, a location information acquisition system. The location information acquisition system is a system designed to acquire the location information of a transmitter that a target person carries with him or her by using the transmitter and a receiver installed at a facility. The location information acquisition system regards the location of the transmitter as the person's current location on the premise that he or she carries the transmitter with him or her. The transmitter has the capability of transmitting a wireless signal. The transmitter transmits the wireless signals in predetermined cycles. The wireless signal may include the identification information of the transmitter. The identification information may be used to distinguish a plurality of transmitters from each other. In the transmitter, the identification information may be stored in, for example, the transmitter's own storage unit. The storage unit may be, for example, a nonvolatile memory such as an electrically erasable programmable read-only memory (EEPROM). The behavior sensor may use, for example, a location information acquisition system that uses a beacon. However, this is only an example and should not be construed as limiting. Alternatively, the behavior sensor may also be a sensor which uses the global positioning system (GPS), for example. Examples of the environmental sensors include an odor sensor, a temperature sensor, a humidity sensor, and a CO₂ sensor.

[0100] In the supplier 7, the generator 71 may include a plurality of atomizers for atomizing solutions containing mutually different functional components. In that case, the airflow control system 100 may have the generator 71 controlled by the control unit 8 to change the functional component supplied to the airflow blowing out from the outlet port 24.

[0101] Also, in the plurality of fins 42 of the first rectifier 4, not all of their first ends 421 and all of their second ends 422 have to overlap with each other, but at least some of their first ends 421 and at least some of their second ends 422 may overlap with each other, when viewed in the axial direction D3 of the fan 3. Alternatively, each of the plurality of fins 42 may also be configured

such that the first end 421 and the second end 422 thereof do not overlap with each other when viewed in the axial direction D3.

[0102] Also, in the second rectifier 5, the rectifying grid 50 does not have to have the honeycomb grid shape but may also have, for example, the shape of a square grid or a triangular grid.

[0103] Furthermore, the second rectifier 5 does not have to be the rectifying grid 50 but may also be a rectifying grid including a bundle of a plurality of (e.g., 19) fine tubes or may also be a porous plate (e.g., a punched metal sheet). Each of the plurality of fine tubes includes the flow channel 55. The porous plate has a plurality of through holes serving as the plurality of flow channels 55.

[0104] Optionally, the air blower 1 may further include a third rectifier interposed, in the axial direction D3 of the fan 3, between the first rectifier 4 and the second rectifier 5. The third rectifier includes an inner cylindrical member, which is disposed inside the cylindrical member 2 to be coaxial with the cylindrical member 2, and a plurality of attachments for attaching the inner cylindrical member to the cylindrical member 2. The inside diameter and outside diameter of the inner cylindrical member decrease in the axial direction D3 of the fan 3 toward the outlet port 24. The third rectifier functions as a diaphragm which rectifies the airflow to further increase the velocity of the airflow in the first region, and to further decrease the velocity of the airflow in the second region, downstream of the first rectifier 4. The inner cylindrical member may have the shape of a circular cylinder, of which the inside and outside diameters are constant in the axial direction D3 of the fan 3. Alternatively, the inner cylindrical member may include a diameter narrowing (i.e., tapering) portion, of which the inside and outside diameters change gradually, and a circular cylindrical portion, of which the inside and outside diameters are constant. The air blower 1 including the third rectifier may increase the flow velocity in the inner region of the outlet port 24 and decrease the flow velocity in the outer region of the outlet port 24, thus widening the difference in flow velocity between the inner and outer regions of the outlet port 24 and increasing the degree of directivity of the airflow blowing out from the outlet port 24, compared to the air blower 1 including no third rectifier.

[0105] Optionally, in the air blower 1, the cylindrical member 2 may also serve as the fan housing 33 of the fan 3. Furthermore, in the air blower 1, the cylindrical member 2 may also serve as the cylindrical portion 41 of the first rectifier 4. Furthermore, in the air blower 1, the cylindrical member 2 may also serve as the cylindrical portion 51 of the second rectifier 5.

[0106] The cylindrical member 2 has only to have the inlet port 23 at the first end 21 thereof and the outlet port 24 at the second end 22 thereof and does not have to have the circular cylindrical shape.

[0107] Alternatively, the air blower 1 may be embedded in a ceiling material such that the outlet port 24 of the cylindrical member 2 faces the target space. Still alternatively, the cylindrical member 2 may also be mounted on either a wall or a pedestal.

[0108] Furthermore, the air blower 1 may also be configured to allow the air coming from an air conditioner unit provided upstream of the air blower 1 to flow into the air blower 1 through the inlet port 23 of the cylindrical member 2. The air conditioner unit may be, but does not have to be, a blower. Alternatively, the air conditioner unit may also be, for example, a ventilator, an air conditioner, an air supplying cabinet fan, or an air conditioning system including a blower and a heat exchanger.

[0109] (Aspects)

The foregoing description provides specific implementations of the following aspects of the present disclosure.

[0110] A control method according to a first aspect is designed to control a system including an air blower (1) and a supplier (7; 7a). The air blower (1) has an outlet port (24), from which an airflow with a degree of straightness is allowed to blow out. The air blower (1) may adjust a velocity of the airflow blowing out from the outlet port (24). The supplier (7; 7a) may supply the airflow blowing out from the outlet port (24) with a functional component to be eventually emitted into the air. The control method includes: performing fluctuation control on the velocity of the airflow blowing out from the outlet port (24); and allowing, when the velocity of the airflow is greater than a threshold value (V1), the functional component to be supplied from the supplier (7; 7a) to the airflow.

[0111] The control method according to the first aspect may contribute to increasing the degree of comfort.

[0112] In a control method according to a second aspect, which may be implemented in conjunction with the first aspect, the supplier (7; 7a) is configured to supply the functional component from a functional material containing the functional component. The control method includes allowing, when the velocity of the airflow is equal to or less than a second threshold value (V2) greater than a first threshold value (V1) as the threshold value (V1), the functional component to be supplied from the supplier (7; 7a) to the airflow.

[0113] The control method according to the second aspect enables limiting the amount of the functional component used by the supplier (7).

[0114] A control method according to a third aspect, which may be implemented in conjunction with the second aspect, includes preventing, even when the velocity of the airflow has become

greater than the first threshold value (V1) before a predetermined amount of time (T1) passes since a point in time when the functional component started to be supplied, the functional component from being supplied from the supplier (7) to the airflow.

[0115] The control method according to the third aspect may reduce the frequency at which the functional component is supplied from the supplier (7) to the airflow.

[0116] In a control method according to a fourth aspect, which may be implemented in conjunction with the first aspect, the supplier (7; 7a) is configured to generate the functional component from a component in the air and supply the functional component. The control method includes: causing, when performing the fluctuation control on the velocity of the airflow blowing out from the outlet port (24), the velocity of the airflow to vary within a range equal to or higher than a first velocity (VL) and equal to or lower than a second velocity (VH); and allowing, when the velocity of the airflow is greater than the threshold value (V1), the functional component to be supplied from the supplier (7a) to the airflow. The threshold value (V1) is less than the first velocity (VL).

[0117] The control method according to the fourth aspect allows the functional component to be supplied continuously in a period during which the airflow blowing out from the outlet port (24) of the air blower (1) varies within the range equal to or higher than the first velocity (VL) and equal to or lower than the second velocity (VH).

[0118] A control method according to a fifth aspect, which may be implemented in conjunction with the second or third aspect, includes preventing, when a flow velocity of an airstream blowing out from an air conditioner (201) is greater than the second threshold value (V2), the functional component from being supplied from the supplier (7) to the airflow. The air conditioner (201) is configured to perform air conditioning on an air-conditioning area including a space to which the airflow is supplied from the air blower (1).

[0119] The control method according to the fifth aspect may reduce the chances of the functional component being diffused by being affected by the airstream blowing out from the air conditioner (201).

[0120] A control method according to a sixth aspect, which may be implemented in conjunction with any one of the first to fifth aspects, includes preventing, when a decision is made that an airstream blows out from an air conditioner (201) toward a space to which the airflow blowing out from the air blower (1) is supplied, the functional component from being supplied from the supplier (7; 7a) to the airflow.

[0121] The control method according to the sixth aspect may reduce the chances of the functional

component being diffused by being affected by the airstream blowing out from the air conditioner (201).

[0122] A control method according to a seventh aspect, which may be implemented in conjunction with any one of the first to sixth aspects, includes preventing, when an evaluation value provided by a detection unit (11) is greater than a prescribed value, the functional component from being supplied from the supplier (7; 7a) to the airflow. The detection unit (11) detects presence of a person within a detection area, including the space to which the airflow is supplied from the air blower (1), to output the evaluation value indicating magnitude of movement representing the person's movement.

[0123] The control method according to the seventh aspect may reduce the chances of the functional component being diffused by the movement of the person.

[0124] A control method according to an eighth aspect, which may be implemented in conjunction with the first aspect, has a plurality of control modes including: a first control mode in which the functional component is allowed to be supplied from the supplier (7) to the airflow when the velocity of the airflow is greater than the threshold value (V1); and a second control mode in which the functional component is allowed to be supplied to the airflow when the velocity of the airflow is equal to or less than a predetermined value smaller than the threshold value (V1). The control method includes controlling the supplier (7) in either the first control mode or the second control mode in accordance with an operating command entered through an operating unit to be operated by a person.

[0125] The control method according to the eighth aspect allows the range in which the functional component is carried to be changed by letting the person operate the operating unit.

[0126] A control method according to a ninth aspect, which may be implemented in conjunction with the first aspect, has a plurality of control modes including: a first control mode in which the functional component is allowed to be supplied from the supplier (7) to the airflow when the velocity of the airflow is greater than the threshold value (V1); and a second control mode in which the functional component is allowed to be supplied to the airflow when the velocity of the airflow is equal to or less than a predetermined value smaller than the threshold value (V1). The control method includes controlling the supplier (7) in either the first control mode or the second control mode according to the number of persons detected by a human detection sensor.

[0127] The control method according to the ninth aspect allows, when the number of persons detected is one, for example, the supplier (7) to be controlled in the first control mode and allows, when the number of persons detected is equal to or greater than two, the supplier (7) to be

controlled in the second control mode. This control method may make, when the number of persons detected is one, the range in which the functional component is carried narrower than when the number of persons detected is equal to or greater than two. In other words, this control method may make, when the number of persons detected is equal to or greater than two, the range in which the functional component is carried broader than when the number of persons detected is one.

[0128] A program according to a tenth aspect is designed to cause a computer system to perform the control method according to any one of the first to ninth aspects.

[0129] The program according to the tenth aspect may contribute to increasing the degree of comfort.

[0130] An airflow control system (100; 100a; 100b; 100c) according to an eleventh aspect includes an air blower (1), a supplier (7; 7a), and a control unit (8). The air blower (1) has an outlet port (24), from which an airflow with a degree of straightness is allowed to blow out. The air blower (1) may adjust a velocity of the airflow blowing out from the outlet port (24). The supplier (7; 7a) may supply the airflow blowing out from the outlet port (24) with a functional component to be eventually emitted into the air. The control unit (8) controls the air blower (1) and the supplier (7; 7a). The control unit (8) controls the air blower (1) to perform fluctuation control on the velocity of the airflow blowing out from the outlet port (24). The control unit (8) controls the supplier (7; 7a) to allow, when the velocity of the airflow is greater than a threshold value (V1), the functional component to be supplied from the supplier (7; 7a) to the airflow.

[0131] The control system (100; 100a; 100b; 100c) according to the eleventh aspect may contribute to increasing the degree of comfort.

Reference Signs List

[0132]	1	Air Blower
	24	Outlet Port
	7, 7a	Supplier
	8	Control Unit
	11	Detection Unit
	100, 100a, 100b, 100c	Airflow Control System
	201	Air Conditioner
	T1	Predetermined Amount of Time
	t1	Point in Time

t2	Point in Time
t3	Point in Time
V1	Threshold Value (First Threshold Value)
V2	Second Threshold Value
VL	First Velocity
VH	Second Velocity

CLAIMS

1. A control method designed to control a system including an air blower and a supplier,
the air blower having an outlet port, from which an airflow with a degree of straightness is allowed to blow out, the air blower being configured to adjust a velocity of the airflow blowing out from the outlet port,
the supplier being configured to supply the airflow blowing out from the outlet port with a functional component to be eventually emitted into the air,
the control method comprising:
performing fluctuation control on the velocity of the airflow blowing out from the outlet port; and
allowing, when the velocity of the airflow is greater than a threshold value, the functional component to be supplied from the supplier to the airflow.
2. The control method of claim 1, wherein
the supplier is configured to supply the functional component from a functional material containing the functional component, and
the control method includes allowing, when the velocity of the airflow is equal to or less than a second threshold value greater than a first threshold value as the threshold value, the functional component to be supplied from the supplier to the airflow.
3. The control method of claim 2, comprising preventing, even when the velocity of the airflow has become greater than the first threshold value before a predetermined amount of time passes since a point in time when the functional component started to be supplied, the functional component from being supplied from the supplier to the airflow.
4. The control method of claim 1, wherein
the supplier is configured to generate the functional component from a component in the air and supply the functional component, and
the control method includes:
causing, when performing the fluctuation control on the velocity of the airflow blowing

out from the outlet port, the velocity of the airflow to vary within a range equal to or higher than a first velocity and equal to or lower than a second velocity; and

allowing, when the velocity of the airflow is greater than the threshold value, the functional component to be supplied from the supplier to the airflow,

the threshold value being less than the first velocity.

5. The control method of claim 2 or 3, comprising preventing, when a flow velocity of an airstream blowing out from an air conditioner is greater than the second threshold value, the functional component from being supplied from the supplier to the airflow, the air conditioner being configured to perform air conditioning on an air-conditioning area including a space to which the airflow is supplied from the air blower.

6. The control method of any one of claims 1 to 5, comprising preventing, when a decision is made that an airstream blows out from an air conditioner toward a space to which the airflow blowing out from the air blower is supplied, the functional component from being supplied from the supplier to the airflow.

7. The control method of any one of claims 1 to 6, comprising preventing, when an evaluation value provided by a detection unit is greater than a prescribed value, the functional component from being supplied from the supplier to the airflow, the detection unit being configured to detect presence of a person within a detection area, including the space to which the airflow is supplied from the air blower, to output the evaluation value indicating magnitude of movement representing the person's movement.

8. The control method of claim 1, wherein

the control method has a plurality of control modes including:

a first control mode in which the functional component is allowed to be supplied from the supplier to the airflow when the velocity of the airflow is greater than the threshold value; and

a second control mode in which the functional component is allowed to be supplied to the airflow when the velocity of the airflow is equal to or less than a predetermined value smaller than the threshold value, and

the control method includes controlling the supplier in either the first control mode or the second control mode in accordance with an operating command entered through an operating unit

to be operated by a person.

9. The control method of claim 1, wherein
the control method has a plurality of control modes including:
a first control mode in which the functional component is allowed to be supplied from the supplier to the airflow when the velocity of the airflow is greater than the threshold value; and
a second control mode in which the functional component is allowed to be supplied to the airflow when the velocity of the airflow is equal to or less than a predetermined value smaller than the threshold value, and
the control method includes controlling the supplier in either the first control mode or the second control mode according to a numerical number of persons detected by a human detection sensor.
10. A program designed to cause a computer system to perform the control method of any one of claims 1 to 9.
11. An airflow control system comprising:
an air blower having an outlet port, from which an airflow with a degree of straightness is allowed to blow out, the air blower being configured to adjust a velocity of the airflow blowing out from the outlet port;
a supplier configured to supply the airflow blowing out from the outlet port with a functional component to be eventually emitted into the air; and
a control unit configured to control the air blower and the supplier,
the control unit being configured to:
control the air blower to perform fluctuation control on the velocity of the airflow blowing out from the outlet port; and
control the supplier to allow, when the velocity of the airflow is greater than a threshold value, the functional component to be supplied from the supplier to the airflow.