

[DESCRIPTION]

[Title of Invention] LIGHTING FIXTURE AND LIGHTING SYSTEM

[Technical Field]

[0001]

5 The present invention relates to a lighting fixture and a lighting system.

[Background Art]

[0002]

10 Depending on a color of light emitted from a lighting fixture or the like, the temperature a person feels is known to change, or more specifically, a person feels warm or cool. For example, a person feels cool (has a cool feeling) when seeing cool color light and feels warm (has a warm feeling) when seeing warm color light.

[0003]

15 Using this, for example, Patent Literature (PTL) 1 discloses a lighting device that maintains or increases comfort of a person by controlling a light color of a light source according to the humidity and temperature.

[Citation List]

20 [Patent Literature]

[0004]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2009-230907

[Summary of Invention]

25 [Technical Problem]

[0005]

30 However, a conventional lighting fixture like the lighting device disclosed in PTL 1 causes the color of the light to vary within a specified range of correlated color temperature. For this reason, the conventional lighting fixture may lack the effect of causing a warm or cool feeling, in particular a cool feeling.

[0006]

35 In view of this, the present invention has an object to provide a lighting fixture and so forth that are capable of effectively causing a person to feel a warm or cool feeling.

[Solution to Problem]

[0007]

A lighting fixture according to an aspect of the present invention is a lighting fixture that is adjustable for an amount and a color of light emitted from the lighting fixture, and includes: a first light source that emits first light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in a CIE 1931 color space xy chromaticity diagram; a second light source that emits second light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy chromaticity diagram; and a light source controller that obtains a light modulation signal used for adjusting the amount and the color of the light emitted from the lighting fixture, and adjusts an amount of light for each of the first light source and the second light source based on the light modulation signal.

[0008]

Furthermore, a lighting system according to an aspect of the present invention includes: a first lighting fixture that is the lighting fixture according to one of claim 1 and claim 2; and a signal generator that generates the light modulation signal, wherein the light source controller obtains the light modulation signal from the signal generator.

[0009]

Furthermore, a lighting system according to an aspect of the present invention includes: a first lighting fixture that is adjustable for an amount and a color of light emitted from the first lighting fixture; and a signal generator, wherein the first lighting fixture includes: a first light source that emits first light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.405, 0.262)$, $(x, y) = (0.634, 0.319)$, $(x, y) = (0.460, 0.510)$, and $(x, y) = (0.330, 0.482)$ in a CIE 1931 color space xy chromaticity diagram; a second light source that emits second

light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.181, 0.032)$, $(x, y) = (0.315, 0.200)$, $(x, y) = (0.180, 0.430)$, and $(x, y) = (0.069, 0.283)$ in the CIE 1931 color space xy chromaticity diagram; a third
5 light source that emits third light of a fixed color included in a basic color name area circle of a white color defined by JIS Z 8110-1995; and a light source controller that obtains, from the signal generator, a light modulation signal used for adjusting the amount and the color of the light emitted from the first lighting fixture, and adjusts an
10 amount of light for each of the first light source, the second light source, and the third light source, based on the light modulation signal, wherein the signal generator generates the light modulation signal that causes the first lighting fixture to emit light of a color having chromaticity coordinates located in a quadrilateral area with
15 four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in the CIE 1931 color space xy chromaticity diagram or chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy chromaticity diagram.

[Advantageous Effects of Invention]

[0010]

A lighting fixture and so forth according to the present
25 invention are capable of effectively causing a person to feel a warm or cool feeling.

[Brief Description of Drawings]

[0011]

FIG. 1 is a diagram schematically illustrating a configuration of
30 a lighting system according to an embodiment.

FIG. 2 is a block diagram illustrating a configuration of the lighting system according to the embodiment.

FIG. 3 is a CIE 1931 color space xy chromaticity diagram for describing colors of light emitted from a first light source, a second
35 light source, and a third light source included in a first lighting fixture

according to the embodiment.

FIG. 4 is a schematic diagram illustrating cross-sectional views of the first light source, the second light source, and the third light source included in the first lighting fixture according to the embodiment.

FIG. 5 is the CIE 1931 color space xy chromaticity diagram illustrating an example of a toning range of the first lighting fixture according to the embodiment.

FIG. 6 is a diagram illustrating emission spectrums of second light emitted from the second light source of the first lighting fixture according to the embodiment.

FIG. 7 is a flowchart of example operation 1 performed by a signal generator according to the embodiment.

FIG. 8 is a flowchart of example operation 2 performed by the signal generator according to the embodiment.

FIG. 9 is a flowchart of example operation 3 performed by the signal generator according to the embodiment.

FIG. 10A is a diagram for describing an example of a relationship between room temperature and comfort.

FIG. 10B is a diagram for describing an example of a relationship between room temperature and comfort.

FIG. 11 is a block diagram illustrating a configuration of a lighting system according to a variation of the embodiment.

FIG. 12 is a CIE 1931 color space xy chromaticity diagram for describing colors of light emitted from a first light source and a second light source included in a first lighting fixture according to the variation of the embodiment.

[Description of Embodiment]

[0012]

Hereinafter, embodiments will be described in detail with reference to the Drawings. Note that each of the following embodiments shows a generic or specific example. The numerical values, shapes, materials, components, the arrangement and connection of the components, steps, the processing order of the steps, etc., shown in the following embodiments are mere examples,

and thus are not intended to limit the present invention. Furthermore, the respective figures are schematic diagrams in which emphasis, omission, or proportion adjustment has been carried out in order to show the present invention. The respective figures are not necessarily accurate illustrations, and thus actual shapes, positional relations, and proportions may differ.

[0013]

[Embodiment]

The following describes a lighting fixture and a lighting system according to the present embodiment.

[0014]

[Configuration of Lighting System]

A configuration of the lighting system according to the present embodiment is first described with reference to FIG. 1 and FIG. 2.

[0015]

FIG. 1 is a diagram schematically illustrating a configuration of lighting system 1 according to the present embodiment. FIG. 2 is a block diagram illustrating the configuration of lighting system 1 according to the present embodiment.

[0016]

Lighting system 1 includes first lighting fixture 10, second lighting fixture 20, lighting control device 30, and operator 40. Lighting control device 30 includes signal generator 31 that generates a first light modulation signal that is an example of a light modulation signal used for adjusting an amount and a color of light emitted from first lighting fixture 10. In the present Description, first lighting fixture 10 is an example of a lighting fixture. Although not illustrated, each of first lighting fixture 10, second lighting fixture 20, lighting control device 30, and operator 40 is supplied with operating electric power from an internal electric power source, such as a battery, or from an external electric power source. Lighting system 1 is installed in an indoor space, such as an office, a factory, a commercial facility, a hotel, or a restaurant.

[0017]

First lighting fixture 10 is adjustable for an amount and a color

of light emitted from first lighting fixture 10. First lighting fixture 10 emits light of a color that causes a person to feel a warm-cold feeling. First lighting fixture 10 emits light to walls and/or a ceiling of the indoor space mainly. For example, first lighting fixture 10 is a space-creation lighting fixture, and thus used for space creation in an indoor space. To be more specific, first lighting fixture 10 is a lighting fixture for coffer lighting, cornice lighting, cove lighting, or floor-stand lighting. First lighting fixture 10 illustrated in the example is mounted on a ceiling. However, first lighting fixture 10 may be mounted to a wall or set to stand on a floor surface. In FIG. 1, the number of first lighting fixtures 10 included in lighting system 1 is two. However, the number of first lighting fixtures 10 included in lighting system 1 is not limited to two, and may one or three or more.

[0018]

Second lighting fixture 20 emits white light. Second lighting fixture 20 emits light to a floor surface of the indoor space mainly. For example, second lighting fixture 20 is a work lighting fixture, and thus emits light necessary for work (such as reading, writing, visual work, hand work, operation using an electronic device, and eating) of a worker in the indoor space. To be more specific, second lighting fixture 20 is used for downlighting, ceiling lighting, or base lighting. In FIG. 1, the number of second lighting fixture 20 included in lighting system 1 is three. However, the number of second lighting fixture 20 included in lighting system 1 is not limited to three, and may be one, two, or four or more.

[0019]

Second lighting fixture 20 may include a plurality of light sources, and may be capable of dimming and toning by adjusting the amount of light for each of the plurality of light sources. The tone of white light emitted from second lighting fixture 20 is adjusted in a range of correlated color temperature between 2700 K to 7200 K. The tone of white light emitted from second lighting fixture 20 may be adjusted in a range of correlated color temperature between 2700 K to 6500 K.

[0020]

Here, light emission ranges of first lighting fixture 10 and second lighting fixture 20 are described.

[0021]

5 Second lighting fixture 20 emits light to work area A in which a worker performs work. The center of the light emission range of second lighting fixture 20 (a direction of the optical axis) is located in a floor surface of the indoor space or in a horizontal surface of a work desk, for example.

10 [0022]

 First lighting fixture 10 emits light outside the light emission range of second lighting fixture 20. The light emission range of first lighting fixture 10 may partly (for example, half or less than half the light emission range of first lighting fixture 10) overlap or may not
15 overlap with the light emission range of second lighting fixture 20. The center of the light emission range of first lighting fixture 10 is located outside the light emission range of second lighting fixture 20, for example. The center of the light emission range of first lighting fixture 10 is located in a vertical plane, such as a wall, a shelf, or a
20 partition in the indoor space. For example, first lighting fixture 10 does not emit light to work area A. If the plurality of first lighting fixtures 10 are used as illustrated in the diagram, the light emission ranges of second lighting fixtures 20 may be located between the light emission ranges of the plurality of first lighting fixtures 10.

25 [0023]

 In this way, second lighting fixture 20 emits the white light to work area A. Moreover, first lighting fixture 10 emits, outside the light emission range of second lighting fixture 20, the light of a color that causes the person to feel a warm or cool feeling as described
30 below. If working in light of a chromatic color like the light of the color that causes the person to feel the warm or cool feeling, the worker may feel uncomfortable and thus working efficiency of the worker may decrease. If working in the indoor space including lighting system 1, the worker does not have to work in the light of a
35 chromatic color like the light of the color that causes the person to

feel the warm or cool feeling. More specifically, the worker can work in work area A illuminated by the white light for working. Thus, lighting system 1 controls an impression of the indoor space and thereby effectively causes the person to feel the warm or cool feeling,
5 without reducing the working efficiency of the worker.

[0024]

Lighting control device 30 is a control device that generates the first light modulation signal used for adjusting an amount and a color of light emitted from first lighting fixture 10. To be more
10 specific, signal generator 31 of lighting control device 30 generates the first light modulation signal. Lighting control device 30 generates the first light modulation signal on the basis of information from various sensors or operation information from operator 40. Lighting control device 30 transmits the generated first light
15 modulation signal to first lighting fixture 10. For example, lighting control device 30 integrated with first lighting fixture 10 is installed in the indoor space. Lighting control device 30 may be separate from first lighting fixture 10 and placed in a location different from the location of first lighting fixture 10. For lighting system 1
20 including the plurality of first lighting fixtures 10, lighting control device 30 may be integrated with each of the plurality of first lighting fixtures 10. At least one lighting control device 30 may be integrated with at least one first lighting fixture 10. Then, the at least one lighting control device 30 may transmit the first light
25 modulation signal to the plurality of first lighting fixtures 10.

[0025]

Operator 40 is a remote controller that receives an operation from a user and that causes first lighting fixture 10 and second lighting fixture 20 to operate in response to the received operation.
30 Operator 40 transmits the operation information that is used for causing first lighting fixture 10 and second lighting fixture 20 to operate and that is thus related to lighting-up, lighting-out, dimming, or toning of first lighting fixture 10 and second lighting fixture 20. Operator 40 receives the operation from the user and generates the
35 operation information based on the received operation. Operator 40

transmits the operation information to signal generator 31. For example, operator 40 is a wall-mounted controller. Operator 40 may be an operating remote controller or a wall switch, for instance. Operator 40 may be implemented by installing an application
5 program onto a general-purpose mobile terminal, such as a smartphone or a tablet terminal.

[0026]

Next, first lighting fixture 10 and lighting control device 30 of lighting system 1 are described in detail.

10 [0027]

[First Lighting Fixture]

As illustrated in FIG. 2, first lighting fixture 10 includes first light source 11, second light source 12, third light source 13, and light source controller 15.

15 [0028]

Colors of light emitted from first light source 11, second light source 12, and third light source 13 are first described. FIG. 3 is a CIE 1931 color space xy chromaticity diagram illustrating the colors of light emitted from first light source 11, second light source 12, and
20 third light source 13 included in first lighting fixture 10 according to the present embodiment.

[0029]

Each of first light source 11, second light source 12, and third light source 13 emits light of a different color. Note that first
25 lighting fixture 10 need not include third light source 13.

[0030]

First light source 11 emits first light of a fixed light color. As illustrated in FIG. 3, the light color of the first light has chromaticity coordinates located in quadrilateral area C1 with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in the CIE 1931 color space xy chromaticity diagram. The light color of the first light is a warm light color. The first light having the light color at the chromaticity coordinates in area C1 increases the luminous efficiency of first light
35 source 11 and also increases the effect of causing the person to feel

a warm feeling.

[0031]

Second light source 12 emits second light of a fixed light color. As illustrated in FIG. 3, the light color of the second light has chromaticity coordinates located in quadrilateral area C2 with four vertices at $(x, y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy chromaticity diagram. The light color of the second light is a cool light color. The second light having the light color at the chromaticity coordinates in area C2 increases the luminous efficiency of second light source 12 and also increases the effect of causing the person to feel a cool feeling.

[0032]

For example, a straight line passing through coordinates $(x, y) = (0.302, 0.692)$ and the equal energy white point at $(x, y) = (0.333, 0.333)$ is a boundary in the CIE 1931 color space xy chromaticity diagram. With respect to this boundary, a light color at chromaticity coordinates on the positive side in the x-axis direction is a warm color. Moreover, with respect to this boundary, a light color at chromaticity coordinates on the negative side in the x-axis direction is a cool color, for example.

[0033]

Third light source 13 emits third light of a fixed light color. As illustrated in FIG. 3, the light color of the third light is within basic color name area circle C3 of white color defined by JIS Z 8110-1995. Basic color name area circle C3 of white color defined by JIS Z 8110-1995 is an area specified in the CIE 1931 color space xy chromaticity diagram, by elliptic equations expressed as: center coordinates $(0.333, 0.333)$; semi-major axis $a = 0.070$; semi-minor axis $b = 0.025$; and slope θ (deg) with respect to major axis $x = 59$. Third light source 13 that emits the third light of the white color is included in first lighting fixture 10. This facilitates the adjustment of a light color of the light emitted from first lighting fixture 10.

[0034]

A maximum allowable amount of the second light emitted from

second light source 12 may be greater than a maximum allowable amount of the first light emitted from first light source 11. For example, an increase in the suppliable amount of current or in the number of second light-emitting devices 121 described later increases the maximum allowable amount of the second light emitted from second light source 12. This enables first lighting fixture 10 to emit a large amount of the second light of a cool light color that is required more than warm color light to make the person feel comfortable.

10 [0035]

If at least two of first light source 11, second light source 12, and third light source 13 emit light, first lighting fixture 10 emits light generated by mixing the light emitted from the at least two light sources.

15 [0036]

Next, configurations of first light source 11, second light source 12, and third light source 13 are described in detail. FIG. 4 is a schematic diagram illustrating cross-sectional views of first light source 11, second light source 12, and third light source 13 included in first lighting fixture 10 according to the present embodiment.

20 [0037]

As illustrated in FIG. 4, first light source 11 includes first light-emitting device 111, first fluorescent element 112, and sealant 200. First light source 11 is a chip-on-board (COB) light-emitting module. First light source 11 has first light-emitting device 111 mounted on board 300 and is sealed by sealant 200 in which first fluorescent elements 112 are dispersed. The first light emitted from first light source 11 is a mix of light from first light-emitting device 111 and light from first fluorescent element 112. Although not illustrated, first light-emitting device 111 includes a metallic line for electric power supply, for example.

30 [0038]

Second light source 12 includes second light-emitting device 121, second fluorescent element 122, and sealant 200. The second light emitted from second light source 12 is a mix of light from

second light-emitting device 121 and light from second fluorescent element 122. Third light source 13 includes third light-emitting device 131, third fluorescent element 132, and sealant 200. The third light emitted from third light source 13 is a mix of light from
5 third light-emitting device 131 and light from third fluorescent element 132. Each of second light source 12 and third light source 13 has the same configuration as first light source 11, and thus description of these light sources is omitted. Each of second light source 12 and third light source 13 is supplied with electric power
10 from a circuit different from the circuit for first light source 11.

[0039]

First light source 11, second light source 12, and third light source 13 may be surface-mount device (SMD) light-emitting modules. Alternatively, first light source 11, second light source 12,
15 and third light source 13 may be remote phosphor light-emitting modules. The number of first light source 11, second light source 12, and third light source 13 may be adjusted as appropriate according to the intended use.

[0040]

20 For example, each of first light-emitting device 111, second light-emitting device 121, and third light-emitting device 131 is either a blue light-emitting diode (blue LED) or a violet LED. A blue LED emits blue light with a main emission peak in a wavelength region from 430 nm to 460 nm. A violet LED emits violet light with
25 a main emission peak in a wavelength region from 380 nm to 430 nm. Examples of the blue LED and the violet LED include a gallium nitride LED. First light-emitting device 111, second light-emitting device 121, and third light-emitting device 131 may be LEDs that have the emission peaks at the same wavelength or at different wavelengths.
30 To simplify power circuit design by equalizing their current-voltage characteristics, first light-emitting device 111, second light-emitting device 121, and third light-emitting device 131 are to be LEDs of the kind having the same emission peak wavelength. Note that first light-emitting device 111, second light-emitting device 121, and
35 third light-emitting device 131 may be collectively referred to simply

as the "light-emitting device".

[0041]

First fluorescent element 112 is excited by at least a part of light from first light-emitting device 111, and emits light of a wavelength longer than that of the light from first light-emitting device 111. For example, first fluorescent element 112 includes at least one of a red phosphor or a yellow phosphor. The number of kinds of phosphors included in first fluorescent element 112 may be one or two or more.

10 [0042]

Second fluorescent element 122 is excited by at least a part of light from second light-emitting device 121, and emits light of a wavelength longer than that of the light from second light-emitting device 121. For example, second fluorescent element 122 includes at least one of a blue phosphor or a green phosphor. The number of kinds of phosphors included in second fluorescent element 122 may be one or two or more.

[0043]

Third fluorescent element is excited by at least a part of light from third light-emitting device 131, and emits light of a wavelength longer than that of the light from third light-emitting device 131. For example, third fluorescent element 132 includes at least one of a red phosphor, a yellow phosphor, a green phosphor, or a blue phosphor. Note that first fluorescent element 112, second fluorescent element 122, and third fluorescent element 132 may be collectively referred to simply as the "fluorescent element".

[0044]

A red phosphor is excited by light from the blue LED or the violet LED and thereby emits red light having a main emission peak in a wavelength region from 600 nm to 650 nm. Examples of the red phosphor include $\text{Ca-}\alpha\text{-SiAlON:Eu}^{2+}$, $\text{CaAlSiN}_3\text{:Eu}^{2+}$, $(\text{Sr, Ca})\text{AlSiN}_3\text{:Eu}^{2+}$, $\text{Sr}_2\text{Si}_5\text{N}_8\text{:Eu}^{2+}$, $\text{Sr}_2(\text{Si, Al})_5(\text{N, O})_8\text{:Eu}^{2+}$, CaS:Eu^{2+} , and $\text{La}_2\text{O}_2\text{S:Eu}^{2+}$.

[0045]

35 A yellow phosphor is excited by light from the blue LED or the

violet LED and thereby emits yellow light having a main emission peak in a wavelength region from 540 nm to 600 nm. Examples of the yellow phosphor include $(Y, Gd)_3Al_5O_{12}:Ce^{3+}$, $Y_3Al_5O_{12}:Ce^{3+}$, Pr^{3+} , $(Tb, Gd)_3Al_5O_{12}:Ce^{3+}$, $(Sr, Ba)_2SiO_4:Eu^{2+}$, $(Sr, Ca)_2SiO_4:Eu^{2+}$,
5 $CaSi_2O_2N_2:Eu^{2+}$, $Ca-\alpha-SiAlON:Eu^{2+}$, $Y_2Si_4N_6C:Ce^{3+}$, and $CaGa_2S_4:Eu^{2+}$.

[0046]

A blue phosphor is excited by light from the blue LED or the violet LED and thereby emits blue light having a main emission peak
10 in a wavelength region from 440 nm to 480 nm. Examples of the blue phosphor include $(Ca, Sr, Ba)MgAl_{10}O_{17}Eu^{2+}$, $(Ba, Sr, Ca, Mg)_2SiO_4Eu^{2+}$, $(Mg, Ca, Sr, Ba)Si_2O_2N_2:Eu^{2+}$, $(Ba, Sr, Ca)_3Si_6O_{12}N_2:Eu^{2+}$, and $(Ba, Sr, Ca)_3Si_6O_9N_4:Eu^{2+}$.

[0047]

A green phosphor is excited by light from the blue LED or the violet LED and thereby emits green light having a main emission peak in a wavelength region from 480 nm to 540 nm. Examples of the green phosphor include $Y_3Al_5O_{12}:Ce^{3+}$, $Tb_3Al_5O_{12}:Ce^{3+}$, $BaY_2SiAl_4O_{12}:Ce^{3+}$, $Ca_3Sc_2Si_3O_{12}:Ce^{3+}$, $(Ba, Sr)_2SiO_4:Eu^{2+}$,
20 $CaSc_2O_4:Ce^{3+}$, $Ba_3Si_6O_{12}:Eu^{2+}$, $\beta-SiAlON:Eu^{2+}$, and $SrGa_2S_4:Eu^{2+}$.

[0048]

Note that the above examples of the phosphor for each color are merely examples. Phosphors commonly vary significantly in characteristics. On this account, a phosphor having one of the
25 aforementioned composition formulas classified according to color may emit light of a color different from its corresponding classified color.

[0049]

The kind of phosphor to be included, a combination ratio for at least two kinds of phosphors to be included, and the amount of phosphor to be mixed with sealant 20 are adjusted for each of first fluorescent element 112, second fluorescent element 122, and third fluorescent element 132. This adjustment enables the first light, the second light, and the third light to achieve their intended colors.

35 [0050]

Sealant 200 is a translucent resin material that individually seals first light-emitting device 111, second light-emitting device 121, and third light-emitting device 131. Light from first light-emitting device 111, second light-emitting device 121, third light-emitting device 131, first fluorescent element 112, second fluorescent element 122, and third fluorescent element 132 is to pass through the translucent resin material. However, the translucent resin material is not limited to a particular material. Examples of the translucent resin material include a silicone resin, an epoxy resin, and a urea resin. For first light source 11, second light source 12, and third light source 13 illustrated in FIG. 2, the same kind of sealant 200 is used. However, a different kind of sealant may be used for each of first light source 11, second light source 12, and third light source 13.

[0051]

First light source 11, second light source 12, and third light source 13 are mounted on board 300. For example, board 300 is a metal-base board, a resin board, or a ceramic board.

[0052]

Referring back to FIG. 2, light source controller 15 obtains the first light modulation signal by receiving the first light modulation signal from an external source, or more specifically, from signal generator 31. Then, on the basis of the first light modulation signal, light source controller 15 adjusts the amount of light for each of first light source 11, second light source 12, and third light source 13. In this way, dimming and toning are performed on the light emitted from first lighting fixture 10.

[0053]

Light source controller 15 provides electric power individually to first light source 11, second light source 12, and third light source 13 from a power circuit, for example. Light source controller 15 individually varies the amount of current for each of the light sources and thereby adjusts the amount of light for each of the first light, the second light, and the third light. Furthermore, control performed by light source controller 15 includes lighting-up and lighting-out.

More specifically, light source controller 15 includes a dimmer switch, the power circuit, a current control circuit, and a dimming circuit. Light source controller 15 may further include a memory and a processor. Furthermore, light source controller 15 may also include
5 a communication circuit for teleoperated control.

[0054]

Note that light source controller 15 may receive the information from the various sensors or the operation information, and may obtain the first light modulation signal by generating the
10 first light modulation signal on the basis of the received information.

[0055]

[Lighting Control Device]

Next, lighting control device 30 is described. As illustrated in FIG. 2, lighting control device 30 includes signal generator 31,
15 communicator 32, clock circuit 33, temperature sensor 34, and light sensor 35. Note that at least one of communicator 32, clock circuit 33, temperature sensor 34, and light sensor 35 need not be included in lighting control device 30.

[0056]

20 Signal generator 31 generates the first light modulation signal used for adjusting an amount and a color of light emitted from first lighting fixture 10. For example, signal generator 31 is directly connected to light source controller 15 of first lighting fixture 10, and transmits the generated first light modulation signal to light source
25 controller 15. Here, if first lighting fixture 10 and lighting control device 30 are separately located, signal generator 31 may transmit the first light modulation signal to light source controller 15 via communicator 32 through wired or wireless communication.

[0057]

30 Moreover, signal generator 31 may generate a second light modulation signal used for adjusting an amount and a color of light emitted from second lighting fixture 20. In this case, signal generator 31 transmits the second light modulation signal to second lighting fixture 20 via communicator 32 via wired or wireless
35 communication, for example.

[0058]

For example, signal generator 31 obtains operation information from operator 40 via communicator 32. Then, on the basis of the obtained operation information, signal generator 31
5 generates the first light modulation signal that causes first lighting fixture 10 to operate according to an operation received by operator 40 from the user. Moreover, signal generator 31 may generate the second light modulation signal that causes second lighting fixture 20 to operate according to the operation received by operator 40 from
10 the user.

[0059]

Furthermore, signal generator 31 obtains environmental information indicating at least one of a set temperature of air conditioner 50, an air temperature, a season, or a time of day, for
15 example. Then, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit light of a color (a cool color or a warm color, for example) determined on the basis of the obtained environmental information.

[0060]

Moreover, signal generator 31 obtains light color information indicating a correlated color temperature of light emitted from second lighting fixture 20, for example. Then, signal generator 31
20 generates the first light modulation signal that causes first lighting fixture 10 to emit light of a color (a cool color or a warm color, for example) determined on the basis of the obtained light color information.
25

[0061]

Furthermore, signal generator 31 obtains light amount information indicating the amount of light emitted from second
30 lighting fixture 20, for example. Then, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit light of the amount determined on the basis of the obtained light amount information.

[0062]

35 Furthermore, signal generator 31 stores an information table

that associates each of the environmental information, the light color information, and the light amount information with a color and/or an amount of light to be emitted from first lighting fixture 10. Signal generator 31 determines the color and/or the amount of light to be emitted from first lighting fixture 10 by reference to the information table, for example.

[0063]

Signal generator 31 includes a central processing unit (CPU) and memories, such as a random access memory (RAM) and a read only memory (ROM). Signal generator 31 may be a microcomputer that includes a microprocessor and a memory for storing a program. Alternatively, signal generator 31 may be hardware that includes an analog circuit and a digital circuit.

[0064]

Communicator 32 is a communication circuit via which signal generator 31 receives the operation information, the environmental information, the light color information, and the light amount information. For example, communicator 32 receives the operation information, the light color information, and the light amount information from operator 40. For example, communicator 32 receives information indicating a set temperature of air conditioner 50 as the environmental information from air conditioner 50. Communicator 32 transmits the received information to signal generator 31. Moreover, communicator 32 may transmit the first light modulation signal and the second light modulation signal to first lighting fixture 10 and second lighting fixture 20, respectively. Communicator 32 may perform wired or wireless communication. A communication standard of the communication performed by communicator 32 is not limited to a particular standard. Communicator 32 includes a communication interface for wired or wireless communication.

[0065]

Clock circuit 33 counts time and date, and outputs the environmental information indicating a season or a time of day based on the counted time and date.

[0066]

Temperature sensor 34 is a thermometer that detects an air temperature of the indoor space equipped with lighting system 1, for example. Temperature sensor 34 may be implemented by a temperature measuring element or circuit, for example. Temperature sensor 34 outputs the environmental information indicating the detected air temperature.

[0067]

Light sensor 35 is a color photometer that measures an amount and a color of light emitted from sensor lighting fixture 20, for example. Light sensor 35 may be implemented by a photoelectric conversion element or circuit. Light sensor 35 outputs: the light amount information indicating the detected amount of the light emitted from second lighting fixture 20; and the light color information indicating the detected correlated color temperature of the light emitted from second lighting fixture 20.

[0068]

Note that clock circuit 33, temperature sensor 34, and light sensor 35 need not be included in lighting control device 30. Clock circuit 33, temperature sensor 34, and light sensor 35 may be individually installed separately from lighting control device 30, for example. In this case, the respective pieces of information from clock circuit 33, temperature sensor 34, and light sensor 35 may be transmitted to signal generator 31 via communicator 32.

[0069]

[Operation]

Next, an operation of lighting system 1 according to the present embodiment is described.

[0070]

An operation of first lighting fixture 10 is first described.

[0071]

Upon supply of electric power to first lighting fixture 10, first light source 11, second light source 12, and third light source 13 emit light under the control of light source controller 15.

[0072]

On the basis of the first light modulation signal, light source controller 15 individually adjusts the amount of current to be supplied to first light source 11, second light source 12, and third light source 13 and thereby varies the amount of light for each of first light source 11, second light source 12, and third light source 13. In this way, light source controller 15 performs dimming and toning on the light emitted from first lighting fixture 10. Note that light source controller 15 need not supply the electric power to all the light sources, depending on the intended color. Thus, first lighting fixture 10 emits light including at least one of the first light, the second light, or the third light.

[0073]

FIG. 5 is the CIE 1931 color space xy chromaticity diagram illustrating an example of a toning range of first lighting fixture 10 according to the present embodiment. In FIG. 5, first light source 11 emits the first light of the color having chromaticity coordinates L11. Second light source 12 emits the second light of the color having chromaticity coordinates L12. Third light source 13 emits the third light of the color having chromaticity coordinates L13. As illustrated in FIG. 5, toning is performed on the light emitted from first lighting fixture 10 within range L1 enclosed by the line connecting three points of chromaticity coordinates L11, L12, and L13.

[0074]

For example, a lighting fixture like second lighting fixture 20 that is tonable within a common white light range varies the light color within chromaticity coordinates on broken line L2 illustrated in FIG. 5. For example, second lighting fixture 20, which is a work lighting fixture, causes the worker to feel uncomfortable by light in a high hue. To keep the worker from feeling uncomfortable, second lighting fixture 20 varies the tone in a range of correlated color temperature between 2700 K to 7200 K. However, by the light color variation within this range, it is difficult to effectively cause the person to feel the cool feeling.

[0075]

In contrast, first lighting fixture 10 is capable of varying the color of the emitted light up to chromaticity coordinates L12 located outside a specified color temperature range on the high color temperature side. Thus, first lighting fixture 10 can effectively

[0076]

Further explanation is given to the reason why the light color having the chromaticity coordinates located in area C2, like the light color having chromaticity coordinates L12, can effectively cause the person to feel the cool feeling.

[0077]

FIG. 6 illustrates emission spectrums of the second light emitted from second light source 12 of first lighting fixture 10. The solid line in FIG. 6 shows emission spectrum LpB of the second light. As illustrated in FIG. 6, the second light has emission peaks at wavelengths of about 440 nm and about 530 nm. Moreover, the broken line in FIG. 6 shows emission spectrum LB of the light source that emits blue light. The light from the light source that emits the blue light has an emission peak only at a wavelength of about 440 nm.

[0078]

Human visibility is commonly highest at a wavelength of about 560 nm and reduces in a region at wavelengths of 500 nm and lower. For example, the light of a light color like the light color having chromaticity coordinates L12 that easily causes the person to feel the cool feeling can be emitted using the light source that emits the white light and the light source that emits the blue light. However, the emission peak of the blue light is only at the wavelength of about 440 nm. For this reason, the amount of light is likely to be insufficient in view of the human visibility. More specifically, the light source that emits the blue light has a low luminous efficiency. In contrast, the second light has the emission peak at the wavelength of about 530 as well and thus contains the light in the region where the human visibility is high. Thus, second light source 12 has a higher luminous efficiency than the light source that emits the blue light. For

example, the luminous efficiency of second light source 12 is four times the luminous efficiency of the light source that emits the blue light.

[0079]

5 As known from the comfortable region of the Kruithof curve, a person feels gloomy and uncomfortable with a small amount of cool color light like a high color temperature light. In contrast, the person feels more comfortable with a small amount of warm color light like a low color temperature light. Thus, an illumination level
10 at which the person feels comfortable is higher when cool color light is emitted than when warm color light is emitted. For example, when the cool color light is emitted, the illumination level at which the person feels comfortable is ten times as high as when the warm color light is emitted. On this account, to cause the person to feel
15 the cool feeling, second light source 12 that emits the cool color light like the second light is to have a high luminous efficiency.

[0080]

 With this, first lighting fixture 10, which includes second light source 12 having the high luminous efficiency, is capable of adjusting
20 the light color to easily cause the person to feel the cool feeling. Hence, first lighting fixture 10 can more effectively cause the person to feel the cool feeling.

[0081]

 Next, an operation of lighting control device 30, or more specifically, an operation of signal generator 31 of lighting control device 30 is described.

[0082]

 Lighting-up, lighting-out, dimming, and toning are performed for each of first lighting fixture 10 and second lighting fixture 20 of
30 lighting system 1 in response to an operation performed by the user using operator 40. At this time, electric power is being supplied to first lighting fixture 10, second lighting fixture 20, lighting control device 30, and operator 40. Lighting control device 30 (signal generator 31) may perform dimming and toning for each of first
35 lighting fixture 10 and second lighting fixture 20 on the basis of the

information from the various sensors. For example, the user is to choose between: manual dimming and manual toning for each of first lighting fixture 10 and second lighting fixture 20 using operator 40; and automatic dimming and automatic toning performed by lighting control device 30 (signal generator 31) for each of first lighting fixture 10 and second lighting fixture 20.

[0083]

Signal generator 31 generates the first light modulation signal on the basis of the operation information based on the operation performed by the user or the environmental information, the light color information, and the light amount information from the corresponding sensors. Then, signal generator 31 transmits the generated first light modulation signal to first lighting fixture 10. This enables the light emission from first lighting fixture 10 to be controlled. For example, lighting-up, lighting-out, dimming, and toning are performed on first lighting fixture 10. Moreover, signal generator 31 may generate the second light modulation signal on the basis of the operation information based on the operation performed by the user or the environmental information, the light color information, and the light amount information from the corresponding sensors. This enables the light emission from second lighting fixture 20 to be controlled. For example, lighting-up, lighting-out, dimming, and toning are performed on second lighting fixture 20.

[0084]

Example operation 1 performed by signal generator 31 is first described. FIG. 7 is a flowchart of example operation 1 performed by signal generator 31.

[0085]

First, signal generator 31 obtains, from light sensor 35, the light amount information indicating the amount of light emitted from sensor lighting fixture 20 (Step S11). Note that signal generator 31 may obtain the light amount information from operator 40 or second lighting fixture 20 via communicator 32. For example, if the light amount of second lighting fixture 20 is adjusted by the user using

operator 40, signal generator 31 obtains information about the light amount of second lighting fixture 20 set by the user, as the light amount information.

[0086]

5 Next, on the basis of the obtained light amount information, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit the amount of light positively correlated with the amount of light emitted from second lighting fixture 20 (Step S12). More specifically, on the basis of the obtained
10 light amount information, signal generator 31 determines the amount of light to be emitted from first lighting fixture 10 by calculating, using a preset correlation coefficient, the amount of light positively correlated with the amount of light emitted from second lighting fixture 20. Signal generator 31 generates the first light
15 modulation signal that causes first lighting fixture 10 to emit the determined amount of light. The correlation coefficient is set according to an installation environment of light system 1 or a desired level of causing the person to feel the warm or cool feeling, for example.

20 [0087]

 Next, signal generator 31 transmits the generated first light modulation signal to light source controller 15 of first lighting fixture 10 (Step S13). Light source controller 15 obtains the first light modulation signal, and then adjusts the amount of light for each of
25 first light source 11, second light source 12, and third light source 13 on the basis of the obtained first light modulation signal. As a result, dimming is performed on the light emitted from first lighting fixture 10 on the basis of the light amount information.

[0088]

30 In this way, the amount of light emitted from first lighting fixture 10 is positively correlated with the amount of light emitted from second lighting fixture 20. Thus, the amount of light emitted from first lighting fixture 10 changes following a change in the amount of light emitted from second lighting fixture 20. This keeps
35 the amount of the light emitted from first lighting fixture 10 from

being too larger or too smaller than the amount of light emitted from second lighting fixture 20. As a result, the person can feel the warm or cool feeling by an appropriate amount of light.

[0089]

5 Next, example operation 2 performed by signal generator 31 is described. FIG. 8 is a flowchart of example operation 2 performed by signal generator 31.

[0090]

10 First, signal generator 31 obtains, from light sensor 35, the light color information indicating a correlated color temperature of light emitted from second lighting fixture 20 (Step S21). Note that signal generator 31 may obtain the light amount information from operator 40 or second lighting fixture 20 via communicator 32. For example, if the correlated color temperature of second lighting
15 fixture 20 is adjusted by the user using operator 40, signal generator 31 obtains information about the correlated color temperature of second lighting fixture 20 set by the user, as the light color information.

[0091]

20 Next, on the basis of the obtained light color information, signal generator 31 determines whether the color of light emitted from first lighting fixture 10 is to be a warm color or a cool color. If the correlated color temperature of the light emitted from second lighting fixture 20 is 5000 K or higher (YES in Step S22), signal
25 generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit cool color light (Step S23). For example, as the first light modulation signal that causes first lighting fixture 10 to emit the cool color light, signal generator 31 generates the first light modulation signal that causes only second light source
30 12 to emit light or causes second light source 12 to emit the largest amount of light.

[0092]

 If the correlated color temperature of the light emitted from second lighting fixture 20 is lower than 5000 K (NO in Step S22),
35 signal generator 31 generates the first light modulation signal that

causes first lighting fixture 10 to emit warm color light (Step S24). For example, as the first light modulation signal that causes first lighting fixture 10 to emit the warm color light, signal generator 31 generates the first light modulation signal that causes only first light source 11 to emit light or causes first light source 11 to emit the largest amount of light.

[0093]

Next, signal generator 31 transmits the generated first light modulation signal to light source controller 15 of first lighting fixture 10 (Step S25). Light source controller 15 obtains the first light modulation signal, and then adjusts the amount of light for each of first light source 11, second light source 12, and third light source 13 on the basis of the obtained first light modulation signal. As a result, toning is performed on the light emitted from first lighting fixture 10 on the basis of the light color information.

[0094]

Thus, if the light emitted from second lighting fixture 20 has a color that is relatively high in the correlated color temperature among the colors in white light and that thus easily causes the person to feel the cool feeling, first lighting fixture 10 also emits cool color light that causes the person to feel the cool feeling. Furthermore, if the light emitted from second lighting fixture 20 has a color that is relatively low in the correlated color temperature among the colors in white light and that thus easily causes the person to feel the warm feeling, first lighting fixture 10 also emits warm color light that causes the person to feel the warm feeling. Thus, the light from first lighting fixture 10 and the light from second lighting fixture 20 are consistent on whether to cause the cool feeling or the warm feeling to the person. Hence, lighting system 1 can more effectively cause the person to feel the warm or cool feeling.

[0095]

Here, for the determination of whether the color of light emitted from first lighting fixture 10 is to be a warm color, the predetermined reference value of the correlated color temperature of the light emitted from second lighting fixture 20 is not limited to

5000 K. A predetermined value different from 5000 K may be set according to the environment, for example.

[0096]

Next, example operation 3 performed by signal generator 31 is described. FIG. 9 is a flowchart of example operation 3 performed by signal generator 31.

[0097]

First, signal generator 31 obtains the environmental information indicating at least one of a set temperature of air conditioner 50, an air temperature (a room temperature of the space equipped with lighting system 1, for example), a season, or a time of day, from at least one of time clock 33, temperature sensor 34, or air conditioner 50 (Step S31). For example, signal generator 31 obtains the environmental information indicating one of the set temperature of air conditioner 50, the air temperature, the season, and the time of day. Here, signal generator 31 may obtain information indicating the set temperature of air conditioner 50 as the environmental information from air conditioner 50 installed in the indoor space. Alternatively, signal generator 31 may obtain the environmental information from, for example, an external device via communicator 32 using a wide area communication network (not illustrated), such as the Internet.

[0098]

Next, on the basis of the obtained environmental information, signal generator 31 determines the color of light to be emitted from first lighting fixture 10 (Step S32). For example, signal generator 31 determines the color of the light emitted from first lighting fixture 10 on the basis of the obtained environmental information, by reference to the information table. Then, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit the light of the determined color (Step S33). More specifically, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit the light of the color determined on the basis of the obtained light amount information.

[0099]

Next, signal generator 31 transmits the generated first light modulation signal to light source controller 15 of first lighting fixture 10 (Step S34). Light source controller 15 obtains the first light modulation signal, and then adjusts the amount of light for each of first light source 11, second light source 12, and third light source 13 on the basis of the obtained first light modulation signal. As a result, toning is performed on the light emitted from first lighting fixture 10 on the basis of the environmental information.

[0100]

For example, assume that the environmental information indicates the set temperature of air conditioner 50 or the air temperature. In this case, if the set temperature of air conditioner 50 or the air temperature is a predetermined value or greater, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit cool color light. For example, as the first light modulation signal that causes first lighting fixture 10 to emit the cool color light, signal generator 31 generates the first light modulation signal that causes only second light source 12 to emit light or causes second light source 12 to emit the largest amount of light. Furthermore, if the set temperature of air conditioner 50 or the air temperature is smaller than the predetermined value, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit warm color light. For example, as the first light modulation signal that causes first lighting fixture 10 to emit the warm color light, signal generator 31 generates the first light modulation signal that causes only first light source 11 to emit light or causes first light source 11 to emit the largest amount of light. Furthermore, signal generator 31 may generate light that increases in hue of cool color as the set temperature of air conditioner 50 or the air temperature rises greater than the predetermined value. Moreover, signal generator 31 may generate the first light modulation signal that causes first lighting fixture 10 to emit the light that increases in hue of warm color as the set temperature of air conditioner 50 or the air temperature drops smaller than the predetermined value.

[0101]

Thus, when the set temperature of air conditioner 50 or the air temperature is high, the emission of the cool color light causes the person to feel the cool feeling. This makes the person to feel comfortable even when an air conditioner or the like is not used or when the set temperature of the air conditioner is high. As a result, energy used by the air conditioner or the like can be reduced. When the set temperature of air conditioner 50 or the air temperature is low, the emission of the warm color light causes the person to feel the warm feeling. This makes the person to feel comfortable even when an air conditioner of the like is not used or when the set temperature of the air conditioner is low. As a result, energy used by the air conditioner or the like can be reduced.

[0102]

The predetermined value used for the determination is set as appropriate according to an environment or a season, for example. Each of FIG. 10A and FIG. 10B is a diagram illustrating an example of a relationship between room temperature and comfort. Each of FIG. 10A and FIG. 10B illustrates an example of a result of evaluation performed to find out how the color of light emitted into the indoor space influences the relationship between room temperature and comfort. Each of FIG. 10A and FIG. 10B illustrates the example of the result of evaluation made by a test subject in the indoor space in which a room temperature and a light color vary. The result shows an evaluation level of comfort for each room temperature and each light color. Each of the vertical axes in FIG. 10A and FIG. 10B represents the evaluation level of comfort. The evaluation level for the greatest discomfort is -3, and the evaluation level for the greatest comfort is 3. Each of the horizontal axes in FIG. 10A and FIG. 10B represents a room temperature of the indoor space. In each of FIG. 10A and FIG. 10B, the solid line shows the result obtained when warm color light was emitted into the indoor space, and the dotted line shows the result obtained when cool color light was emitted into the indoor space. FIG. 10A shows the result of evaluation performed in summer. FIG. 10B shows the result of

evaluation performed in winter.

[0103]

As shown by the result of evaluation in summer in FIG. 10A, at 25 degrees or lower, the evaluation level of comfort is higher in the indoor space illuminated by the warm color light. Moreover, at 25
5 degrees or higher, the evaluation level of comfort is higher in the indoor space illuminated by the cool color light. As shown by the result of evaluation in winter in FIG. 10B, at 24 degrees or lower, the evaluation level of comfort is higher in the indoor space illuminated
10 by the warm color light. Moreover, at 24 degrees or higher, the evaluation level of comfort is higher in the indoor space illuminated by the cool color light. Thus, to raise the level of comfort for the person, the predetermined value used for the determination is set at between 24 degrees and 25 degrees. On the basis of the
15 information indicating the season, signal generator 31 may determine the predetermined value that is higher in summer than in winter.

[0104]

For example, assume that the environmental information
20 indicates a season. In this case, if the season is summer, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit cool color light. If the season is winter, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit warm color light. If the
25 season is spring or autumn, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit light that is low in hue. For example, as the first light modulation signal that causes first lighting fixture 10 to emit the light that is low in hue, signal generator 31 generates the first light modulation signal
30 that causes only third light source 13 to emit light or causes third light source 13 to emit the largest amount of light. For the environmental information indicating the season as described, the same advantageous effect can be achieved as with the environmental information indicating the set temperature of air conditioner 50 or
35 the air temperature.

[0105]

For example, assume that the environmental information indicates a time of day. In this case, if the time of day indicates daytime, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit cool color light. If the time of day indicates nighttime, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit warm color light. For the environmental information indicating the time of day as described, the same advantageous effect can be achieved as with the environmental information indicating the set temperature of air conditioner 50 or the air temperature.

[0106]

As described, signal generator 31 generates the first light modulation signal that causes first lighting fixture 10 to emit the light of the color determined on the basis of the obtained light amount information. This enables first lighting fixture 10 to emit the light of the color that causes the person to feel the comfort appropriate to the environment, with no user intervention. Hence, lighting system 1 can effectively cause the person to feel the warm or cool feeling.

[0107]

Note that signal generator 31 may generate the second light modulation signal and transmit the generated second light modulation signal to second lighting fixture 20 via communicator 32, similarly to Step S31 to Step S34. As a result, second lighting fixture 20 emits the light of the color determined on the basis of the environmental information as well. This produces a consistent atmosphere in the space equipped with lighting system 1.

[0108]

Furthermore, signal generator 31 may determine the color of the light emitted from first lighting fixture 10 on the basis of environmental information including a combination of at least two of the set temperature of air conditioner 50, the air temperature, the season, or the time of day included in the environmental information.

[0109]

[Advantageous effects etc.]

As described above, first lighting fixture 10 is a lighting fixture that is adjustable for an amount and a color of light emitted from the lighting fixture, and includes first light source 11, second light source 12, and light source controller 15. First light source 11 emits first light of a fixed color that has chromaticity coordinates located in a quadrilateral area C1 with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in a CIE 1931 color space xy chromaticity diagram. Second light source 12 emits second light of a fixed color that has chromaticity coordinates located in a quadrilateral area C2 with four vertices at $(x, y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy chromaticity diagram. Light source controller 15 obtains a first light modulation signal used for adjusting the amount and the color of the light emitted from first lighting fixture 10, and adjusts an amount of light for each of first light source 11 and second light source 12 based on the first light modulation signal.

[0110]

With this, first lighting fixture 10 includes second light source 12 that emits the second light. The color of the second light has the chromaticity coordinates located outside the specified color temperature range on the high color temperature side. Thus, dimming can be performed on the light emitted from first lighting fixture 10 to vary the light color up to the color that has the chromaticity coordinates located outside the specified color temperature range on the high color temperature side and that thus easily causes the person to feel the cool feeling. Hence, first lighting fixture 10 can effectively cause the person to feel the warm or cool feeling. As described above, second light source 12 has a higher luminous efficiency than the light source that emits the blue light to achieve the light color having the chromaticity coordinates in area C2 by a mixture of blue light and white light. Thus, first lighting fixture 10, which includes second light source 12 having the high luminous efficiency, is capable of adjusting the light color to easily cause the person to feel the cool feeling. Hence, first lighting

fixture 10 can more effectively cause the person to feel the cool feeling.

[0111]

As a result, a comfortable space can be made without using an
5 air conditioner, for example. This reduces energy consumption.
Moreover, the comfortable space can be made without increasing a
temperature difference between inside and outside of the space.
This can reduce a load resulting from the body temperature
regulation of the person.

10 [0112]

Furthermore, lighting system 1 further includes third light
source 13 that emits the third light of the light color included in basic
color name area circle C3 of white color defined by JIS Z 8110-1995.
Light source controller 15 individually adjusts the amount of light for
15 each of first light source 11, second light source 12, and third light
source 13 on the basis of the first light modulation signal.

[0113]

Thus, first lighting fixture 10 includes third light source 13 that
emits the third light of the light color having the chromaticity
20 coordinates between the first light and the second light in the CIE
1931 color space xy chromaticity diagram. With this, the light color
of the light emitted from first lighting fixture 10 can be easily
adjusted.

[0114]

25 Furthermore, lighting system 1 includes first lighting fixture
10 and signal generator 31 that generates the first light modulation
signal.

[0115]

This enables lighting system 1 to cause first lighting fixture 10
30 to emit the light that effectively causes the person to feel the cool
feeling.

[0116]

Furthermore, lighting system 1 further includes second
lighting fixture 20 that emits white light, for example. First lighting
35 fixture 10 emits the light outside a range of light emission of second

lighting fixture 20.

[0117]

With this, lighting system 1 causes second lighting fixture 20 to emit the white light appropriate to work or the like performed by the person within the emission range of second lighting fixture 20 while causing first lighting fixture 10 emit the light to the surroundings of the person. This effectively makes the person feel the warm or cool feeling.

[0118]

10 [Variation]

The following describes Variation of Embodiment. Variation of Embodiment mainly describes differences from Embodiment, and thus simplifies or omits the description that is the same as in Embodiment.

15 [0119]

FIG. 11 is a block diagram illustrating a configuration of lighting system 1a according to the present variation. As illustrated in FIG. 11, lighting system 1a includes first lighting fixture 10a and lighting control device 30a that includes signal generator 31a, in place of first lighting fixture 10 and lighting control device 30 that includes signal generator 31 in lighting system 1 according to Embodiment.

[0120]

First lighting fixture 10a includes first light source 11a and second light source 12a, in place of first light source 11 and second light source 12 of first lighting fixture 10 according to Embodiment. First light source 11a and second light source 12a are different in light color from first light source 11 and second light source 12.

[0121]

30 FIG. 12 is a CIE 1931 color space xy chromaticity diagram illustrating colors of light emitted from first light source 11a and second light source 12a included in first lighting fixture 10a.

[0122]

As illustrated in FIG. 12, a color of first light emitted from first light source 11a has chromaticity coordinates located in quadrilateral

area C1a with four vertices at $(x, y) = (0.405, 0.262)$, $(x, y) = (0.634, 0.319)$, $(x, y) = (0.460, 0.510)$, and $(x, y) = (0.330, 0.482)$ in the CIE 1931 color space xy chromaticity diagram.

[0123]

5 A color of second light emitted from second light source 12a has chromaticity coordinates located in quadrilateral area C2a with four vertices at $(x, y) = (0.181, 0.032)$, $(x, y) = (0.315, 0.200)$, $(x, y) = (0.180, 0.430)$, and $(x, y) = (0.069, 0.283)$ in the CIE 1931 color space xy chromaticity diagram.

10 [0124]

 A straight line connecting the chromaticity coordinates of the first light and the chromaticity coordinates of the third light passes through area C1 in the CIE 1931 color space xy chromaticity diagram. Thus, first lighting fixture 10a can emit the light of the color having
15 the chromaticity coordinates located in area C1. Moreover, a straight line connecting the chromaticity coordinates of the second light and the chromaticity coordinates of the third light passes through area C2 in the CIE 1931 color space xy chromaticity diagram. Thus, first lighting fixture 10a can emit the light of the color having
20 the chromaticity coordinates located in area C2.

[0125]

 As in Embodiment, the kind of phosphor to be included, a combination ratio for at least two kinds of phosphors to be included, and the amount of phosphor to be mixed with sealant 200 are
25 adjusted for each of fluorescent elements included in first light source 11a and second light source 12a. This adjustment enables the first light and the second light to achieve their intended colors.

[0126]

 For example, signal generator 31a generates the first light
30 modulation signal that causes first lighting fixture 10a to emit light of a color having: the chromaticity coordinates located in quadrilateral area C1 with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in the CIE 1931 color space xy chromaticity diagram; or the chromaticity
35 coordinates located in quadrilateral area C2 with four vertices at $(x,$

$y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$,
and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy
chromaticity diagram. For example, signal generator 31a generates
the first light modulation signal that causes first lighting fixture 10a
5 to emit the light of the color having the chromaticity coordinates in
area C1 by adjusting the amount of light for each of first light source
11a and third light source 13. Moreover, signal generator 31a
generates the first light modulation signal that causes first lighting
fixture 10a to emit the light of the color having the chromaticity
10 coordinates in area C2 by adjusting the amount of light for each of
second light source 12a and third light source 13.

[0127]

Furthermore, signal generator 31a performs the same
operations as those performed by signal generator 31 according to
15 Embodiment, such as the operations performed in the example
operations described above.

[0128]

As described thus far, lighting system 1a according to the
present variation includes first lighting fixture 10a that emits the
20 light of the colors having the chromaticity coordinates located in area
C1 and area C2, as with lighting system 1 according to Embodiment.
Hence, lighting system 1a according to the present variation can
effectively cause the person to feel the warm or cool feeling.

[0129]

25 [Other Embodiments]

Although the present invention has been described by way of
Embodiment above, it should be obvious that the present invention is
not limited to Embodiment described above.

[0130]

30 For example, although lighting system 1 according to
Embodiment described above includes lighting control device 30 and
operator 40, this is not intended to be limiting. The components
included in lighting control device 30 may be included in first light
source 10, second lighting fixture 20, or operator 40. For example,
35 signal generator 31 may be included in first light source 10, second

lighting fixture 20, or operator 40. Alternatively, signal generator 31 may be included in light source controller 15. Operator 40 may be included in first light source 10, second lighting fixture 20, or lighting control device 30.

5 [0131]

Furthermore, lighting system 1 need not include second lighting fixture 20. For example, lighting system 1 may be a single lighting unit that includes first lighting fixture 10 and lighting control device 30 that includes at least signal generator 31.

10 [0132]

Furthermore, in the above embodiments, a process executed by a specific component may be executed by a different component. Moreover, the order in which processes are executed may be changed, and a plurality of processes may be executed in parallel.

15 [0133]

Moreover, in the above embodiments, each of the components may be realized by executing a software program suited to the component. The components may be implemented by a program executor such as a CPU or a processor reading out and executing the software program recorded in a recording medium such as a hard disk or a semiconductor memory.

20

[0134]

Furthermore, the respective components may be implemented using hardware. The respective components may be circuits (or integrated circuits). These circuits as a whole may compose a single circuit or may be individual circuits. Moreover, each of the structural components may be implemented by a general-purpose processor or a dedicated processor.

25

[0135]

Furthermore, the generic or specific aspects of the present invention may be implemented as a system, an apparatus, a method, an integrated circuit, a computer program, or a computer-readable recording medium such as a CD-ROM, or may be implemented as any combination of a system, an apparatus, a method, an integrated circuit, a computer program, and a recording medium.

30

35

[0136]

For example, the present invention may be implemented as the lighting system in the above embodiments, as a program for causing a computer to execute a lighting program, or as a
5 non-transitory computer-readable recording medium having such a program recorded thereon.

[0137]

Other forms realized through various modifications to the embodiments and variation conceived by a person of ordinary skill in
10 the art or through any combination of the components and functions in the embodiments described above, so long as they do not depart from the essence of the present invention, are included in the present invention.

[Reference Signs List]

15 [0138]

1, 1a	lighting system
10, 10a	first lighting fixture (lighting fixture)
11, 11a	first light source
12, 12a	second light source
20 13	third light source
15	light source controller
20	second lighting fixture
31, 31a	signal generator
50	air conditioner
25 A	work area

[CLAIMS]

[Claim 1]

A lighting fixture that is adjustable for an amount and a color of light emitted from the lighting fixture, the lighting fixture
5 comprising:

a first light source that emits first light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in a CIE 1931 color space
10 xy chromaticity diagram;

a second light source that emits second light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.200, 0.175)$, $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931
15 color space xy chromaticity diagram; and

a light source controller that obtains a light modulation signal used for adjusting the amount and the color of the light emitted from the lighting fixture, and adjusts an amount of light for each of the first light source and the second light source based on the light
20 modulation signal.

[Claim 2]

The lighting fixture according to claim 1, further comprising:
a third light source that emits third light of a fixed color
25 included in a basic color name area circle of a white color defined by JIS Z 8110-1995,

wherein the light source controller adjusts the amount of light for each of the first light source, the second light source, and the third light source, based on the light modulation signal.
30

[Claim 3]

A lighting system comprising:
a first lighting fixture that is the lighting fixture according to one of claim 1 and claim 2; and
35 a signal generator that generates the light modulation signal,

wherein the light source controller obtains the light modulation signal from the signal generator.

[Claim 4]

5 A lighting system comprising:

a first lighting fixture that is adjustable for an amount and a color of light emitted from the first lighting fixture; and

a signal generator,

wherein the first lighting fixture includes:

10 a first light source that emits first light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.405, 0.262)$, $(x, y) = (0.634, 0.319)$, $(x, y) = (0.460, 0.510)$, and $(x, y) = (0.330, 0.482)$ in a CIE 1931 color space xy chromaticity diagram;

15 a second light source that emits second light of a fixed color that has chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.181, 0.032)$, $(x, y) = (0.315, 0.200)$, $(x, y) = (0.180, 0.430)$, and $(x, y) = (0.069, 0.283)$ in the CIE 1931 color space xy chromaticity diagram;

20 a third light source that emits third light of a fixed color included in a basic color name area circle of a white color defined by JIS Z 8110-1995; and

a light source controller that obtains, from the signal generator, a light modulation signal used for adjusting the amount and the color of the light emitted from the first lighting fixture, and
25 adjusts an amount of light for each of the first light source, the second light source, and the third light source, based on the light modulation signal,

wherein the signal generator generates the light modulation
30 signal that causes the first lighting fixture to emit light of a color having chromaticity coordinates located in a quadrilateral area with four vertices at $(x, y) = (0.380, 0.330)$, $(x, y) = (0.510, 0.360)$, $(x, y) = (0.470, 0.440)$, and $(x, y) = (0.350, 0.420)$ in the CIE 1931 color space xy chromaticity diagram or chromaticity coordinates
35 located in a quadrilateral area with four vertices at $(x, y) = (0.200,$

0.175), $(x, y) = (0.275, 0.270)$, $(x, y) = (0.220, 0.360)$, and $(x, y) = (0.155, 0.275)$ in the CIE 1931 color space xy chromaticity diagram.

5 [Claim 5]

The lighting system according to one of claim 3 and claim 4, further comprising:

a second lighting fixture that emits white light,
wherein the first lighting fixture emits the light outside a range
10 of light emission of the second lighting fixture.

[Claim 6]

The lighting system according to claim 5,
wherein the second lighting fixture emits light to a work area
15 in which a worker performs work.

[Claim 7]

The lighting system according to one of claim 5 and claim 6,
wherein the second lighting fixture is adjustable for an amount
20 of light, and

the signal generator obtains light amount information indicating the amount of light emitted from the second lighting fixture, and generates, based on the light amount information obtained, the light modulation signal that causes the first lighting
25 fixture to emit the amount of light positively correlated with the amount of light emitted from the second lighting fixture.

[Claim 8]

The lighting system according to any one of claim 5 to claim 7,
30 wherein the signal generator obtains light color information indicating a correlated color temperature of light emitted from the second lighting fixture, and generates, based on the light color information obtained, the light modulation signal that causes the first lighting fixture to emit light of a cool light color if the correlated
35 color temperature of the white light emitted from the second lighting

fixture is 5000 K or higher and to emit light of a warm light color if the correlated color temperature of the white light emitted from the second lighting fixture is lower than 5000 K.

5 [Claim 9]

The lighting system according to any one of claim 3 to claim 7,
wherein the signal generator obtains environmental
information indicating at least one of a set temperature of an air
conditioner, an air temperature, a season, or a time of day, and
10 generates the light modulation signal that causes the first lighting
fixture to emit light of a light color determined based on the
environmental information obtained.