

# LIGHTING CONTROLLER APPARATUS AND LIGHTING CONTROL METHOD

## Background

[0001] The present invention relates to a lighting  
5 control technique of on/off-controlling a plurality of  
lighting devices arranged in a facility.

[0002] In the past, there is proposed a lighting  
control technique of using a so-called pyroelectric  
infrared sensor, i.e., thermopile, thermistor, porometer,  
10 or another type of infrared detection device, detecting  
presence/absence of a person in a lighting area of the  
lighting device, and turning on/off the lighting device  
on a basis of the detection result (for example, see  
Japanese Patent Application Laid-open No. 2013-093103 and  
15 the like).

[0003] The lighting control technique utilizes the  
property of illuminance change or heat transfer  
corresponding to movement of a person in the lighting  
area. According to the lighting control technique, the  
20 lighting device is on/off-controlled on a basis of the  
person detection result detected on a basis of the  
illuminance change or the heat transfer.

[0004] According to such a lighting control technique,  
the following situation may be occur. In some cases, for  
25 example, a person may be at a border of a lighting area.  
If the lighting device is turned on/off simply on a basis  
of the person detection result, the person detection  
result may be changed frequently as the person moves  
slightly. As a result, the lighting device may be turned  
30 on and off again and again. If the lighting device is  
turned on and off again and again, not only the person

may feel uncomfortable but also it may shorten the life of the lighting device.

[0005] In the past, in the lighting control technique, there is used a so-called delay control technique to

5 reduce occurrence of such frequent turning on and off. According to the delay control, when detecting a person and then detecting no person, a lighting device is turned off not immediately. The lighting device is turned off with delay of a predetermined delay time length after the

10 time point at which no person is detected.

[0006] However, according to such lighting control in the past, the following situation may occur. For example, late at night, a small number of persons are in the space. For example, a person walks in the space in

15 this situation. In his/her walking paths, each lighting device of each lighting area has been turned off. In this case, as a result, each lighting device is turned on. After that, each lighting device is turned off with delay of a predetermined delay time length as the result

20 of the delay control. As a result, even after the person passes through the lighting area, the lighting device is still turned on, which is wasteful. As a result, wasteful power consumption may be generated, which is a problem.

25 [0007] The present invention has been made in view of the aforementioned circumstances, and it is desirable to provide a lighting control technique capable of executing the delay control effectively depending on the situation of a space.

#### Summary

30 [0008] In view of the above-mentioned circumstances,

according to an embodiment of the present invention,  
there is provided a lighting controller apparatus that  
detects, on a basis of a thermography detected in a space  
under control, a person in the space, and on/off-controls  
5 a lighting device arranged in the space on a basis of an  
obtained person detection result, the lighting controller  
apparatus including: a memory unit that stores, for each  
time slot, a delay time length that is used to delay the  
on/off-control; a person detecting unit that detects a  
10 presence/absence status of a person on a basis of the  
thermography; and a lighting controller unit that  
confirms, on a basis of the detected presence/absence  
status, at least one of a first change from an occupied  
status to a vacant status and a second change from the  
15 vacant status to the occupied status, then obtains, from  
the memory unit, a delay time length of a change-  
confirmed time slot corresponding to change-confirmed  
time point at which the lighting controller unit confirms  
the change, and executes delay control, the delay control  
20 including turning on or off the lighting device with  
delay of the delay time length after the change-confirmed  
time point.

[0009] Further, according to an embodiment of the  
lighting controller apparatus of the present invention,  
25 the memory unit stores, for each time slot, an off delay  
time length and an on delay time length separately as the  
delay time length, and the lighting controller unit  
confirms the first change, and then obtains the off delay  
time length of the change-confirmed time slot from the  
30 memory unit as the delay time length, and confirms the  
second change, and then obtains the on delay time length

of the change-confirmed time slot from the memory unit as the delay time length.

[0010] Further, according to an embodiment of the lighting controller apparatus of the present invention, the memory unit stores, for each time slot, a control flag of the delay control, and the lighting controller unit confirms, when executing the delay control, the control flag of a time slot of a current time stored in the memory unit, executes the delay control where the control flag indicates delay-control-on, and turns off the lighting device where the control flag indicates delay-control-off.

[0011] Further, according to an embodiment of the lighting controller apparatus of the present invention, the delay time length is shorter in a time slot having a higher probability of the vacant status of the space.

Further, according to an embodiment of the lighting controller apparatus of the present invention, the on delay time length is shorter in a time slot in which outside is darker, the on delay time length of the delay time length being used to turn on the lighting device.

[0012] Further, according to an embodiment of the present invention, there is provided a lighting control method of detecting, on a basis of a thermography detected in a space under control, a person in the space, and on/off-controlling a lighting device arranged in the space on a basis of an obtained person detection result, the lighting control method including: by a memory unit, storing, for each time slot, a delay time length that is used to delay the on/off-control; by a person detecting unit, detecting a presence/absence status of a person on

a basis of the thermography; and by a lighting controller unit, confirming, on a basis of the detected presence/absence status, at least one of a first change from an occupied status to a vacant status and a second  
5 change from the vacant status to the occupied status, then obtaining, from the memory unit, a delay time length of a change-confirmed time slot corresponding to change-confirmed time point at which the lighting controller unit confirms the change, and executing delay control,  
10 the delay control including turning on or off the lighting device with delay of the delay time length after the change-confirmed time point.

[0013] According to the present invention, depending on the change-confirmed time slot of the change-confirmed  
15 time point at which the change of the presence/absence status is confirmed, the delay time length used for the delay control, i.e., the time length by which turning on or off is delayed, is switched. As a result, it is possible to effectively execute the delay control  
20 depending on the situation of the space, which is changed depending on the time slots. Therefore, it is possible to set a relatively short delay time length for a time slot such as a late-night time slot in which a small number of persons are in the space. For example, a  
25 person walks in the space in such a time slot. In his/her walking paths, each lighting device of each lighting area has been turned off. In this case, as a result, after turning on each lighting device, the lighting device will be turned off immediately in a short  
30 time. As a result, it is possible to reduce wasteful lighting of the lighting device, and reduce wasteful

power consumption.

These and other objects, features and advantages of the present disclosure will become more apparent in light of the following detailed description of best mode embodiments thereof, as illustrated in the accompanying drawings.

#### Brief Description of Drawings

[0014] Fig. 1 is a block diagram showing a configuration of a lighting controller apparatus;

Fig. 2 shows an example of data structure of delay time length information; and

Fig. 3 is a flowchart showing a lighting control process.

#### Detailed Description of Embodiments

[0015] Hereinafter, an embodiment of the present technology will be described with reference to the drawings.

[Lighting controller apparatus]

Firstly, with reference to Fig. 1, the lighting controller apparatus 10 of an embodiment of the present invention will be described. Fig. 1 is a block diagram showing a configuration of a lighting controller apparatus.

The lighting controller apparatus 10 as a whole is an information processing apparatus such as a controller and a server apparatus for industrial purposes. The lighting controller apparatus 10 detects, on a basis of a thermography detected by the infrared sensors SP arranged in the space R under control, the person U in the space R, and on/off-controls the lighting devices Q arranged in the space R on a basis of an obtained person detection

result.

[0016] The infrared sensors SP are infrared sensors such as thermopile array sensors attached on walls and the ceiling of the space R. The infrared sensor SP has functions of detecting thermographies of the floor surface of the space R at regular intervals, and sending the thermographies to the lighting controller apparatus 10 via the communication line L1.

The lighting devices Q are lighting devices such as fluorescent lamps arranged on the ceiling of the space R. The lighting device Q has a function of being turned on/turned off controlled by the lighting controller apparatus 10 via the communication line L1.

Note that the infrared sensors SP may be arranged at positions, at which the infrared sensors SP are capable of detecting thermographies of lighting areas corresponding to the lighting devices Q. The position relation between the infrared sensors SP and the lighting devices Q is not especially limited.

[0017] The lighting controller apparatus 10 mainly includes, as functional units, the communication I/F unit 11, the thermography obtaining unit 12, the memory unit 13, the person detection unit 14, and the lighting controller unit 15. A central processing unit (CPU) executes programs to realize the thermography obtaining unit 12, the person detection unit 14, and the lighting controller unit 15 out of those functional units.

[0018] The communication I/F unit 11 has a function of sending and receiving data to and from the infrared sensors SP and the lighting devices Q via the communication line L1.

The thermography obtaining unit 12 has functions of obtaining thermographies from the infrared sensors SP received via the communication I/F unit 11, and storing the thermographies in the memory unit 13.

5 [0019] The memory unit 13 includes memory devices such as a hard disk and a semiconductor memory. The memory unit 13 has a function of storing various information-to-be-processed and programs used for a lighting control process of the lighting controller apparatus 10.

10 Examples of such information-to-be-processed stored in the memory unit 13 mainly include thermographies and delay time length information.

[0020] Fig. 2 shows an example of data structure of delay time length information. In this example, for each time slot, the control flag Cont of delay control, the off delay time length Tdoff, and the on delay time length Tdon are registered in combination. The off the delay time length Tdoff indicates the time length of delay until the lighting devices Q are turned off. The on the delay time length Tdon indicates the time length of delay until the lighting devices Q are turned on. Note that one delay time length Td may be used commonly as the off delay time length Tdoff and the on delay time length Tdon.

25 [0021] Fig. 2 shows a set example where the space R is a room of an office. For example, for the time slots "00:00-07:00" and "22:00-24:00", the off delay time length Tdoff=5 sec and the on delay time length Tdon=0 sec are set. In the nighttime, there are very small number of people. In this situation, as a result, it is possible to immediately turn on the lighting device when

30

a person enters a lighting area, and turn off the lighting device just after that a person goes out from the lighting area.

Further, for the time slots "07:00-12:00" and "13:00-18:00", the off delay time length  $T_{doff}=60$  sec and the on delay time length  $T_{don}=60$  sec are set. In the bright daytime, there are many people walking in the room. In this situation, as a result, it is possible to suppress frequent turning on/off since the delay control of enough delay time length.

[0022] Further, for the time slot "18:00-22:00", the off delay time length  $T_{doff}=30$  sec and the on delay time length  $T_{don}=10$  sec are set. In the after-hours time slot when the outside is dark, less people are in the room. In this situation, it is possible to turn on the lighting device just after a person enters a lighting area, and turn off the lighting device after a person goes out from the lighting area in a shorter time than the daytime.

Further, for the time slot "12:00-13:00", the control flag  $Cont=control-off$  is set. In the lunch break time, people do not work. In this situation, the lighting control is stopped, and all the lighting devices  $Q$  are turned off. As a result, it is possible to reduce power consumption.

[0023] The person detecting unit 14 has a function of searching a person area for a temperature distribution obtained from thermographies stored in the memory unit 13 in time series. The person area indicates the skin temperature of the person  $U$ . The person detecting unit 14 has a function of detecting a presence/absence status for each lighting area of the lighting devices  $Q$  on a

basis of the obtained search result. The presence/absence status indicates whether there is at least one person U or not. The person detecting unit 14 has a function of outputting the presence/absence as a detection result.

[0024] The lighting controller unit 15 has a function of, where the detection result obtained by the person detecting unit 14 indicates that the presence/absence status of the lighting area of the lighting devices Q is changed, obtaining the delay time length Td of the change-confirmed time slot Tp corresponding to the change-confirmed time point Tc, at which the change of the presence/absence status is confirmed, from the delay time length information of the memory unit 13. The lighting controller unit 15 has a function of executing delay control, the delay control including turning on or off the lighting devices Q with delay of the obtained delay time length Td after the change-confirmed time point Tc. The lighting controller unit 15 has a function of confirming, when executing the delay control, the control flag of a time slot of a current time with reference to the delay time length information stored in the memory unit 13, executing the delay control where the control flag indicates delay-control-on, and turning off the lighting devices Q without executing the delay control where the control flag indicates delay-control-off.

[0025] [Behavior of embodiment]

Next, with reference to Fig. 3, a behavior of the lighting controller apparatus 10 of the present embodiment will be described. Fig. 3 is a flowchart showing a lighting control process. In an example

described below, the lighting of one lighting device Q is controlled.

[0026] Firstly, the thermography obtaining unit 12 obtains a new thermography sent from the infrared sensors SP, and stores the new thermography in the memory unit 13 (Step 100). The person detecting unit 14 detects the presence/absence status of the person U in the lighting area of the lighting device Q from the new thermography stored in the memory unit 13 (Step 101).

Next, the lighting controller unit 15 refers to the delay time length information of the memory unit 13, and confirms the control flag Cont of the delay control of the current time slot corresponding to the current time (Step 102).

In this case, where the control flag Cont of the current time slot indicates control-off (Step 102: NO), the lighting controller unit 15 does not at all control the lighting on a basis of the person detection result, and turns off the lighting device Q (Step 103). The process proceeds to Step 100.

[0027] Further, where the control flag Cont of the current time slot indicates control-on (Step 102: YES), the lighting controller unit 15 confirms whether or not the presence/absence status of the lighting area of the lighting device Q is changed from the last presence/absence status (Step 104). If the presence/absence status is unchanged (Step 104: NO), the process returns to Step 100.

Meanwhile, if the presence/absence status is changed (Step 104: YES), the lighting controller unit 15 confirms whether or not the change of the presence/absence status

indicates a first change from an occupied status to a vacant status (Step 110).

[0028] Where the change of the presence/absence status indicates the first change (Step 110: YES), the lighting controller unit 15 obtains the off delay time length  $T_{doff}$  of the change-confirmed time slot  $T_p$  from the delay time length information stored in the memory unit 13 as the delay time length  $T_d$  (Step 111). After that, the lighting controller unit 15 calculates the turn-off time  $T_{woff} = T_c + T_{doff}$ . The turn-off time  $T_{woff}$  is delayed by the off delay time length  $T_{doff}$  after the change-confirmed time point  $T_c$  (Step 112). The lighting controller unit 15 turns off the lighting device  $Q$  when it reaches the turn-off time  $T_{woff}$  (Step 113). After that, the process returns to Step 100.

[0029] Further, where the change of the presence/absence status indicates a second change from the vacant status to the occupied status (Step 110: NO), the lighting controller unit 15 obtains the on delay time length  $T_{don}$  of the change-confirmed time slot  $T_p$  from the delay time length information stored in the memory unit 13 as the delay time length  $T_d$  (Step 114). After that, the lighting controller unit 15 calculates the turn-on time  $T_{won} = T_c + T_{don}$ . The turn-on time  $T_{won}$  is delayed by the on delay time length  $T_{don}$  after the change-confirmed time point  $T_c$  (Step 115). The lighting controller unit 15 turns on the lighting device  $Q$  when it reaches the turn-on time  $T_{won}$  (Step 116). After that, the process returns to Step 100.

[0030] [Effects of embodiment]

As described above, according to the present

embodiment, the memory unit 13 prestores, for each time slot, the delay time length  $T_d$  that is used to delay the on/off-control. The lighting controller unit 15 confirms, on a basis of the detected presence/absence status, at least one of a first change from an occupied status to a vacant status and a second change from the vacant status to the occupied status, then obtains, from the memory unit 13, the delay time length  $T_d$  of the change-confirmed time slot  $T_p$  corresponding to the change-confirmed time point  $T_c$  at which the lighting controller unit confirms the change, and executes delay control, the delay control including turning on or off the lighting device  $Q$  with delay of the delay time length  $T_d$  after the change-confirmed time point  $T_c$ .

[0031] As a result, depending on the change-confirmed time slot  $T_p$  of the change-confirmed time point  $T_c$  at which the change of the presence/absence status is confirmed, the delay time length  $T_d$  used for the delay control, i.e., the time length by which turning on or off is delayed, is switched. As a result, it is possible to effectively execute the delay control depending on the situation of the space  $R$ , which is changed depending on the time slots.

Therefore, it is possible to set a relatively short delay time length  $T_d$  for a time slot such as a late-night time slot in which a small number of persons  $U$  are in the space  $R$ . For example, a person walks in the space in such a time slot. In his/her walking paths, each lighting device  $Q$  of each lighting area has been turned off. In this case, as a result, after turning on each lighting device  $Q$ , the lighting device  $Q$  will be turned

off immediately in a short time. As a result, it is possible to reduce wasteful lighting of the lighting device Q, and reduce wasteful power consumption.

[0032] Further, according to the present embodiment, the memory unit 13 may store, for each time slot, the off delay time length Tdoff and the on delay time length Tdon separately as the delay time length Td, and the lighting controller unit 15 may confirm the first change, and then obtains the off delay time length Tdoff of the change-confirmed time slot Tp from the memory unit 13 as the delay time length Td, and confirm the second change, and then obtains the on delay time length Tdon of the change-confirmed time slot Tp from the memory unit 13 as the delay time length Td. As a result, it is possible to set the different delay time lengths Td for the first change and the second change. It is possible to realize the flexible delay control.

[0033] Further, according to the present embodiment, the memory unit 13 may store, for each time slot, a control flag of the delay control, and the lighting controller unit 15 may confirm, when executing the on/off-control on a basis of the delay control time Tw, the control flag of the change-confirmed time slot Tp, execute the on/off-control on a basis of the delay control time Tw where the control flag indicates delay-control-on, and turn off the lighting device Q where the control flag indicates delay-control-off. As a result, it is possible to easily stop the delay control in an arbitrary time slot, and reduce power consumption.

[0034] Further, according to the present embodiment, the delay time length Td may be shorter in a time slot

having a higher probability of the vacant status of the space R. As a result, it is possible to execute the delay control very effectively depending on the situation of the space R.

5           Further, according to the present embodiment, the on delay time length Tdon may be shorter in a time slot in which outside is darker, the on delay time length Tdon of the delay time Td length being used to turn on the lighting device. As a result, it is possible to turn on  
10 the lighting device Q immediately corresponding to movement of a person even if it is dark in the outside. As a result, it is possible to reduce the person's anxiety of the darkness.

[0035]       [Extension of embodiment]

15           It should be understood by those skilled in the art that various modifications, combinations, sub-combinations and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims or the  
20 equivalents thereof.

[0036]       Further, according to the present embodiment, a dimmable device may be used as as the lighting device Q. In this case, the turn-on status may not necessarily be the luminance of 100%. Alternatively, the turn-on status  
25 may be the intermediate luminance. Further, luminance may be preset for each time slot of the delay time length information stored in the memory unit 13 for the on/off-control the lighting device Q. In this case, the lighting controller unit 15 may obtain the luminance  
30 corresponding to each time slot from the delay time length information, and may on/off-control the lighting

device Q.

What is claimed is:

1. A lighting controller apparatus that detects, on a basis of a thermography detected in a space under control, a person in the space, and on/off-controls a lighting device arranged in the space on a basis of an obtained person detection result, the lighting controller apparatus comprising:

a memory unit that stores, for each time slot, a delay time length that is used to delay the on/off-control;

a person detecting unit that detects a presence/absence status of a person on a basis of the thermography; and

a lighting controller unit that  
confirms, on a basis of the detected presence/absence status, at least one of a first change from an occupied status to a vacant status and a second change from the vacant status to the occupied status, then

obtains, from the memory unit, a delay time length of a change-confirmed time slot corresponding to change-confirmed time point at which the lighting controller unit confirms the change, and

executes delay control, the delay control including turning on or off the lighting device with delay of the delay time length after the change-confirmed time point, wherein

the memory unit stores, for each time slot, an off

delay time length and an on delay time length separately as the delay time length, and

the lighting controller unit

confirms the first change, and then obtains the off delay time length of the change-confirmed time slot from the memory unit as the delay time length, and

confirms the second change, and then obtains the on delay time length of the change-confirmed time slot from the memory unit as the delay time length.

2. The lighting controller apparatus according to claim 1, wherein

the memory unit stores, for each time slot, a control flag of the delay control, and

the lighting controller unit

confirms, when executing the delay control, the control flag of a time slot of a current time stored in the memory unit,

executes the delay control where the control flag indicates delay-control-on, and

turns off the lighting device where the control flag indicates delay-control-off.

3. The lighting controller apparatus according to claim 1, wherein

the delay time length is shorter in a time slot having a higher probability of the vacant status of the space.

4. The lighting controller apparatus according to claim

1, wherein

the on delay time length is shorter in a time slot in which outside is darker, the on delay time length of the delay time length being used to turn on the lighting device.

5. A lighting control method of detecting, on a basis of a thermography detected in a space under control, a person in the space, and on/off-controlling a lighting device arranged in the space on a basis of an obtained person detection result, the lighting control method comprising:

by a memory unit, storing, for each time slot, a delay time length that is used to delay the on/off-control;

by a person detecting unit, detecting a presence/absence status of a person on a basis of the thermography; and

by a lighting controller unit,  
confirming, on a basis of the detected presence/absence status, at least one of a first change from an occupied status to a vacant status and a second change from the vacant status to the occupied status, then

obtaining, from the memory unit, a delay time length of a change-confirmed time slot corresponding to change-confirmed time point at which the lighting controller unit confirms the change, and

executing delay control, the delay control

including turning on or off the lighting device with delay of the delay time length after the change-confirmed time point, wherein

the memory unit stores, for each time slot, an off delay time length and an on delay time length separately as the delay time length, and

the lighting controller unit

confirms the first change, and then obtains the off delay time length of the change-confirmed time slot from the memory unit as the delay time length, and

confirms the second change, and then obtains the on delay time length of the change-confirmed time slot from the memory unit as the delay time length.