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Intelligent Lighting System with the Ability to Control the Color Temperature and Light Flow of the Illuminators

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Abstract

Modern lighting products allow the creation of intelligent control systems with the ability to adjust many parameters of lighting devices (for example, luminous flux, color temperature, light color, etc.). The presence on the market of relatively cheap lighting sensors (for illuminance, for color temperature, for light color, for movement, etc.) allows the monitoring of many parameters of the environment and, accordingly, more precise regulation of various parameters.

The report presents a concept for the realization of an intelligent lighting system, which, depending on the external conditions of the environment, can regulate the parameters of an internal lighting system. Regulation is carried out according to external illumination, external color temperature, presence in the room, set algorithm of work, etc. Modern LED light sources with a variable color temperature and the possibility of dimming are planned to be used in the implementation of the system.

A structural diagram of such a system, the element base and the control algorithm is presented.

Index Terms: Intelligent lighting system, LED color temperature

1 Introduction

The modern level of technology makes it possible to create lighting systems with the most diverse functions and capabilities. Systems are available on the market with the ability to adjust the light flow, the color of the emitted light, etc.). A rich element base is also available: various types of lighting fixtures and light modules; sensors for various lighting parameters (illuminance, brightness, color temperature); sensors for various other parameters related to lighting control (presence of movement, presence, etc.); control controllers; different management interfaces and many more.

All this helps in the construction of intelligent lighting systems, allowing lighting control to be used both to reduce the consumption of electrical energy and to provide a more comfortable lighting environment.

The purpose of the report is to present a concept for the creation of an intelligent lighting system with the ability to adjust the light flow and the color temperature of the illuminators.

2 Concept

The main idea of the proposed system consists of the following:

- ✓ Capabilities to be provided by the system:
  - adjustment of the light flow, depending on the external natural lighting and the internal operational lighting;
  - adjustment of the color temperature of the illuminators, depending on the color temperature of the external illumination;
  - manual control if necessary;
  - operation of the lighting system only in the presence of people in the room;
  - remote control of the device;
  - complete integration with the general BMS system of the building;
- ✓ An element base that can be used to realize the concept:
  - LED illuminators or LED modules with the ability to adjust the color temperature, using suitable drivers and a DALI control system;
  - Sensors for internal illuminance measurement, working according to the DALI standard;
  - Sensors for external illuminance measurement, working according to the DALI standard;
  - Sensors for measuring color temperature, working according to the DALI standard;
  - Presence sensors working according to the DALI standard;
  - Elements for manual control - keys and buttons;
  - Suitable DALI controllers to control the system.

3 Implementation of the system

In fig. 1 are shown an exemplary implementation of an intelligent lighting system for a specific room. A specific room was chosen for the purposes of the experimental research - a classroom on the university's territory.

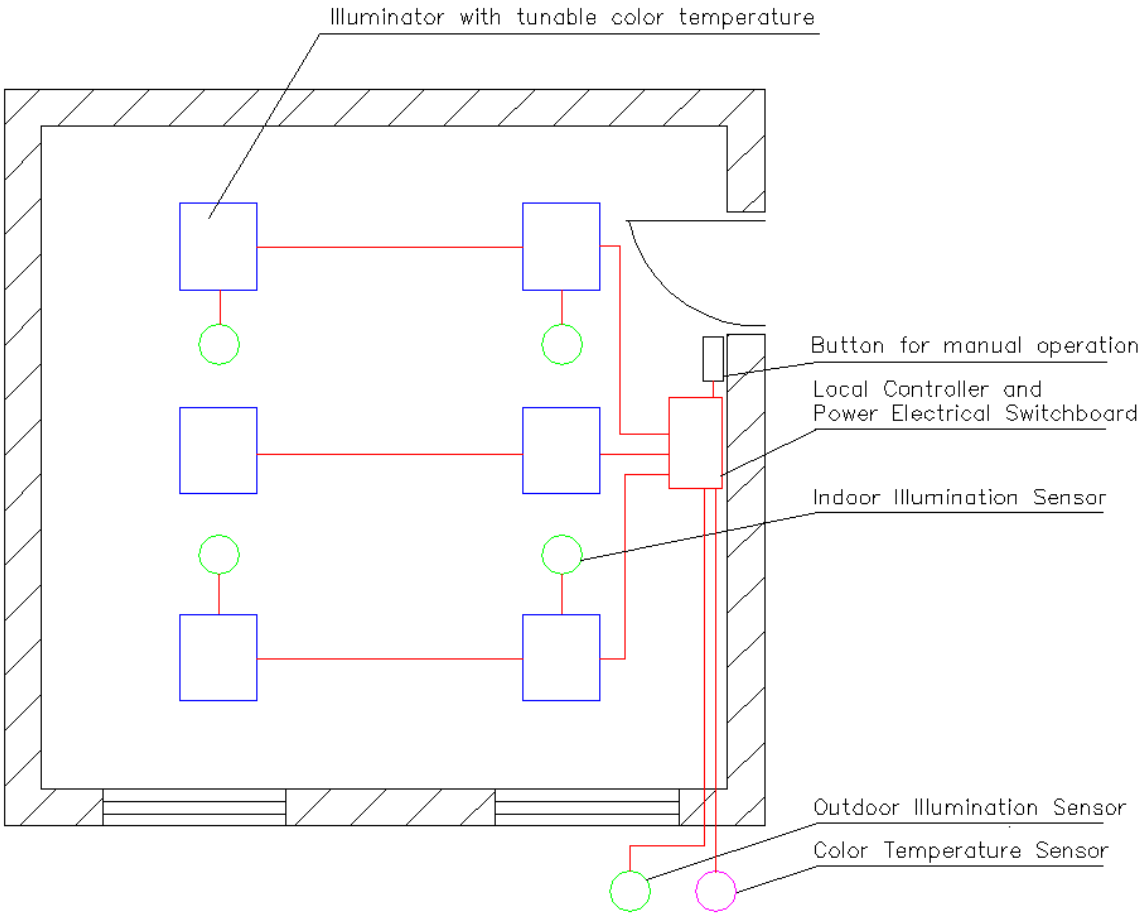

Figure 1. An exemplary implementation of an intelligent lighting system

The existing luminaires with fluorescent lamps are modified and reworked with LED modules with the ability to adjust the light flux and color temperature (Fig. 2). A driver has been added to each illuminator with the ability to adjust the light flux and color temperature of the selected modules. The driver is controlled according to the DALI standard (Fig. 3). To limit glare from the LED modules, specialized diffusers are used, suitably fixed above the LED modules. In fig. 4 are shown pictures of a reconstructed illuminator.

At the moment, the system is partially implemented. The six illuminators were modified, a communication link between the illuminators and the control panel was provided. A control module with Bluetooth communication is connected, which allows control of the lighting drivers using a smartphone or manually.

Upgrading the system with the addition of illuminance sensors and a color temperature sensor is forthcoming. The completion of the system will be the addition of a local controller that will be programmed depending on the monitored parameters (illuminance and color temperature) to manage the LED lights in an appropriate way.

Figure 2. LED module PrevaLED by Osram, with the ability to adjust the color temperature

Figure 3. LED driver Osram Optotronic Intelligent Tunable, with the ability to adjust the color temperature, via DALI interface

Figure 4. Pictures of a modified illuminator

It is also envisaged that the system can be programmed to work as a biodynamic lighting system.

Upon completion of the system, studies of the lighting environment will be conducted using visual tests and survey questionnaires.

4 Conclusion

The presented intelligent lighting system provides opportunities for great flexibility in lighting management. The idea of controlling the light flow is not new, but the addition of the regulation of the color temperature allows for a more precise dosing of the light. The implementation of such a system will lead both to an economy of electrical energy and to the achievement of the so-called circadian lighting (one that is aimed at providing visual and emotional comfort to people).

The system has been partially implemented so far, allowing remote and local control. The addition of a suitable controller to ensure automatic lighting control is pending.

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