A Specialised System for Dynamic Control and Adjustment of the Colour Temperature and Illumination of a Lighting System

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Abstract— **The paper presents the development of an automated system for dynamic control and adjustment of colour temperature and illumination of an indoor lighting system. A proposal is made to use lighting fixtures with LED sources or fluorescent lights T5 with a different colour of lighting, which allow adjustments. The system is controlled by DALI protocol (Digital Addressable Lighting Interface) and specialized microcontrollers. With the help of the automated system a specific colour temperature can be maintained inside the room, depending on the natural outside light. The lighting system is adjusted dynamically, which creates an impression of connection with the outside ambiance.**

Keywords – light control; automated system; DALI; colour temperature.

I. INTRODUCTION

In the last few years, with the dynamic development of the lighting technology, the concept of illuminating closed indoor spaces has been noticeably changing too. Systems for dynamic control of lighting systems have been developed, specialized biodynamic lighting sources have been applied, individual control of single lighting sources has been used, etc. [2] The purpose is the lighting ambiance to be changed according to the psychological awareness and state of those people who are present in the room.

At the same time, some general principles should be followed as well such as [3]:

- building of easily controlled lighting systems;
- achieving energy efficiency;
- flexibility of lighting systems;
- others.

"Intelligent lighting systems", based on controlling the various components of the system through microcontrollers and specialized devices are being mentioned more and more frequently. Some automated systems for controlling lighting systems have been developed by leading companies in the field of lighting technology. These systems, however, adjust predominantly the level of lighting in the room and include additional sensors (for presence, movement, outside lighting, etc.) with the purpose to realize additional energy saving [4,5,6]. To present, no system has been developed that creates a specific colour of lighting in the rooms, corresponding to the colour of natural daylight.

The purpose of this investigation is to develop a specialized automated system for dynamic control and adjustment of colour temperature and illumination of an indoor lighting system.

II. EXPOSITION

An automated system for dynamic control of lighting systems (called **"Indoor Colour Control"**) has been developed. With the help of this system the lighting climate inside the rooms with lighting based on DALI protocol can be monitored and controlled. DALI is a protocol oriented to the control of lighting or, more specifically, to the control of electronic start regulating equipment (ESRE). This protocol includes a set of 250 commands, 90 of which are intended for future expansion and are not used. DALI is a standard directed to a smaller number of users. The number of individual addresses is limited to 64, i.e. up to 64 lighting fixtures are controlled. The standard calls for combining the 64 addresses into 4 groups so that each lighting scenario can be introduced more easily and more conveniently. Since each lighting fixture possesses its own (individual) address, it can emit a light flow independently from the remaining fixtures in the lighting system. This provides exceptional flexibility of the systems built and controlled by this protocol. The deficiency with these systems is that there is no feedback for tracking the ambiance parameters.

The proposed system tracks the lighting parameters of the ambiance (the colour temperature of sunlight; the natural outside illumination and the operational lighting in the room) and, depending on them, controls the indoor lighting system of a specific room (regulating the illumination and the colour temperature of the emitted light).

A. Ambiance architecture

Model ambiance architecture is presented on fig.1.

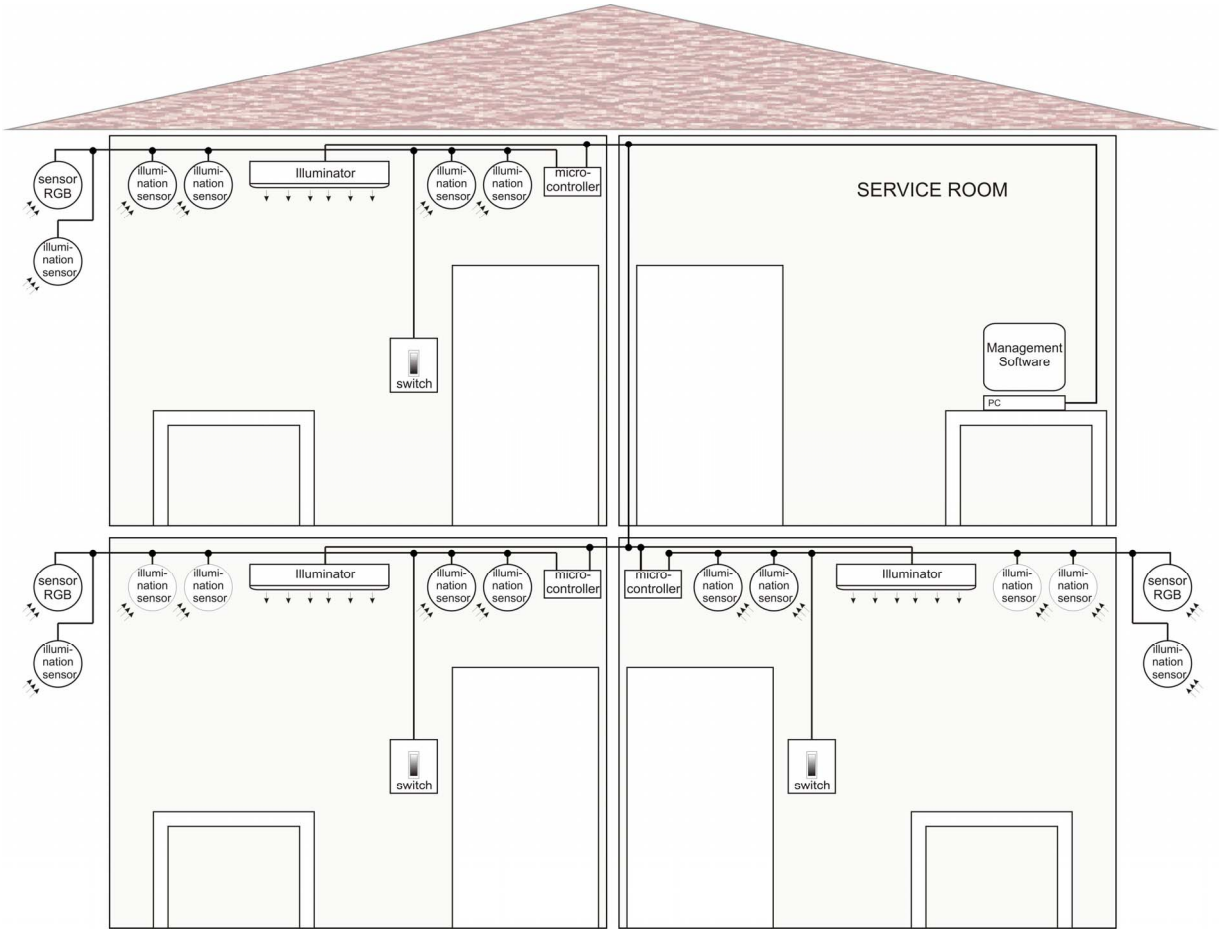

Figure 1. Architecture of the control system for indoor lighting systems

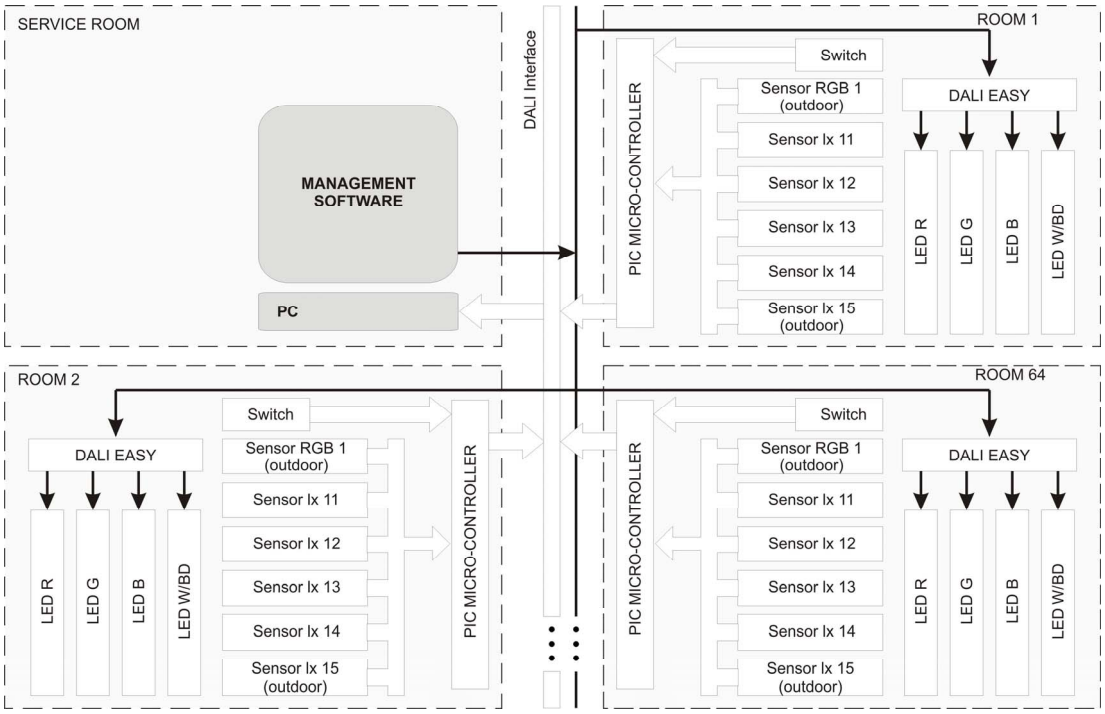

Figure 2. A flow chart of the automated system for control of lighting systems

In each room one to four sensors are installed to measure the operational illumination Em (Illumination Sensor). Outside the room a sensor measuring the sunlight colour temperature (Sensor RGB) and one measuring the natural outside illumination (Illumination Sensor) are installed. The sensor measuring the sunlight colour temperature is supplied with separate registers for blue, red, green and white colour. There are used standard sensors to measure the color temperature and illumination, manufacturing by “ROHM” and “Avago”.

All sensors are connected through a twin-lead line I2C through specialized microcontroller. The microcontroller used is PIC16F1826-I/P, it also supports the I2C interface and is connected to the line.

The values measured by sensors on illumination and color temperature through the specialized controller are transmitted to a computer that manages the entire system. There are used standard computer system and specially developed software (Management Software).

B. Flow chart of the automated system

Besides the above-listed components (microcontroller and sensors for illumination and colour temperature) in each room there is a switch for turning on and off the lights manually. The switch is connected to one of the inputs of the microcontroller. Other control sensors could be added to the system (for presence, movement, etc.), i. e. It is expandable and flexible.

Through using the DALI interface, the microcontroller is connected to a computer, controlling the whole lighting system under DALI protocol. To transfer the data from the microcontroller to the computer, one of the reserved and unused commands in the DALI protocol is used.

The system developed is used for controlling lighting fixtures with LED lighting sources as in each fixture red, blue, green and white colour light source is installed. The system also allows the control of fluorescent lamps T5 with lights of different colour and specialized start regulating equipment.

A flow chart of the automated system for control of indoor lighting systems **Indoor Color Control** is shown on fig. 2.

Besides the standard control algorithm used in the system, lighting scenarios and programmes can be created for a specific room and programmed into the microcontroller.

The use of all these functions makes the system extremely flexible and easily adaptable to specific needs.

The system is built with relatively inexpensive components, which do not add much to the overall price of the system. Moreover, it allows the realization of significant savings of electricity and provides a comfortable lighting climate in the rooms.

III. CONCLUSION

A system for automated control of lighting systems based on the usage of DALI protocol has been developed. The system measures and controls major illuminating technical indexes such as the level of operational illumination, the colour temperature of light and the coefficient of natural illumination. An opportunity is provided for achieving a colour temperature of illumination inside the room, corresponding to the outside colour temperature. In this way, an illumination indoor climate is achieved, which corresponds to the natural outside ambiance illumination climate. All requirements of the currently active standards have been observed [1]. The observers in the closed room where the system developed is used feel as if they are in an outdoor ambiance.

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The study was supported by contract № BG051PO001-3.3.04/28, "Support for the Scientific Staff Development in the Field of Engineering Research and Innovation”. The project is funded with support from the Operational Programme "Human Resources Development" 2007-2013, financed by the European Social Fund of the European Union.