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Intelligent LED Lighting System for Energy Efficiency

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Abstract: ***In the recent trends the use of electronic load is increasing very fast and the gap between demand and supply have made the reliability and power quality a critical issue. The most waste of energy is caused by the inefficient use of the consumer electronics. Particularly, a light accounts for a great part of the total energy consumption. Various light control systems are introduced in current markets, because the installed lighting systems are outdated and energy-inefficient. However, due to architectural limitations, the existing light control systems cannot be successfully applied to home and office buildings. Therefore, this paper proposes an intelligent household LED lighting system considering energy efficiency and users satisfaction. The proposed system utilizes multi sensors and wireless communication technology in order to control an LED light according to the user's state and the surroundings. The proposed LED lighting system can autonomously adjust the minimum light intensity value to enhance both energy efficiency and user satisfaction. We designed and implemented the proposed system in the test bed and measured total power consumption to verify the performance. The proposed LED lighting system reduces total power consumption of the test bed up to 21.9%1.***

Keywords: household LED lighting system, situation awareness, minimum light intensity control, adaptive middleware.

1. Introduction

Energy-saving solutions have been becoming increasingly essential in recent years because of environmental issues such as climate change and global warming [1]-[4]. Environmental problems are very important issues and these problems are largely caused by the excessive use of energy. A light accounts for approximately 20 percent of the world's total energy consumption [5]; thus the related studies of an energy efficient lighting system have been done by various researchers around the world [7]-[14]. The invention of a light emitting diode (LED) is expected to significantly alleviate the energy consumption of a light, because the LED lighting device consumes 50 percent of the energy consumption compared to the fluorescent lighting device. Recently, an intelligent lighting control system using various sensors and communication modules are actively studied and developed in both university and industry [6]. The intelligent lighting control system can reduce energy consumption as automatically controlling the intensity of illumination through situation awareness, such as awareness of user movement or brightness of surroundings. The technical report from the U.S. Department of Energy shows that about 15 percent of total energy consumption can be reduced through light control according to user's living pattern.

There are many researches on the lighting control system. Pan *et al* [7] proposed a wireless sensor network-based intelligent light control system for indoor environments. This light control system manages lighting devices according to user's activities and profiles. Two algorithms (Illumination decision algorithm and device control algorithm) are proposed to meet requirements of the user and to save energy. Uhm*et al*[8] proposed an LED light system with light sensors, motion sensors, and network interfaces. This light control system can control illumination intensity of an LED light based on brightness of surrounding and movement of residents. Park *etal* [9] presented lighting control system based on a building automation and control network (BAC net). Matta *et al* [10] proposed a light control system with detailed design for energy saving by controlling the intensity of illumination. In this paper, a logical low cost design is introduced to conserve electrical energy taking daylight illumination into consideration by using a controller area network (CAN) bus as the media for communication. Bellido-Outeirino *et al* [11] presented building lighting automation system using digital addressable lighting interface (DALI) devices with wireless sensor networks. There are some researches about street lighting control systems. Leccese [12] proposed remote control system can optimize management and efficiency of street lighting systems. It uses ZigBee communications which enable more efficient street lamp-system management.

There are some researches about evaluation of energy-efficiency of lighting systems. Delaney *et al* [13] proposed a wireless sensor network as a evaluation tool that can help in analyzing and evaluating the energy-efficiency of an existing lighting control system in a low-cost. Denardin *et al* [14] presented an intelligent street light controlling and monitoring system based on a wireless data network. This system add communication capabilities to the existing street lighting systems through the integration of a ZigBee compatible transceiver in order to turn each street lighting system in to a node of a large wirelessnetwork.32-bit ARM processor is the contemporary general purpose microprocessor in the embedded market used in industrial level applications. GSM, as we know, is the most widely used mobile Technology. Using a simple Subscriber Identity Module (SIM), it has taken the world of mobile communication to new heights. It is based on a simple architecture. Even with the introduction of new technologies like CDMA, GSM has stood its strength due to its efficiency and simplicity. Atomized irrigation is an interesting application. Primarily for Real time atomization of

agricultural environment for social modernization of Indian agricultural system.

The lighting control system for energy savings in current markets can support on-off and dimming control as managing lighting devices after detecting an object or intensity of illumination, or controlling with time setting. Furthermore, although most existing systems have variable control parameters, it is difficult for users to modify these parameters, so that it is not appropriate to be applied in various places. In addition, although the lighting control system using central management server or sensor networks was studied recently, it was not commercialized or industrialized, and even the commercialized products were excessively concentrated to the central management server.

2. System Design Model

This paper proposes an intelligent household LED lighting system considering energy efficiency and user satisfaction. The proposed system utilizes multi sensors and wireless communication technology in order to control an LED light according to the user's state and the surroundings. The proposed LED lighting system can autonomously adjust the minimum light intensity value to enhance both energy efficiency and user satisfaction.

A. Hardware Section

The prototype and hardware block diagram of the proposed system. The main processor part uses 32-bitmicroprocessor. This part plays a role in situation analysis, event processing, and learning. This part optimizes the control and state variables to adapt itself to the various environments. The sensor part is composed of various sensors. To provide energy saving services mentioned above, two kinds of sensors, that is a motion detection sensor and illumination sensor are needed basically. A ZigBee (250 kbps/2.4 GHz) module is used for communication with other LED lighting system and networked devices. LED driver part consists of current controller modules for driving LEDs. There are two ports that are controllable and are able to control for 255levels of brightness. The power part is composed of a power regulator and SMPS.

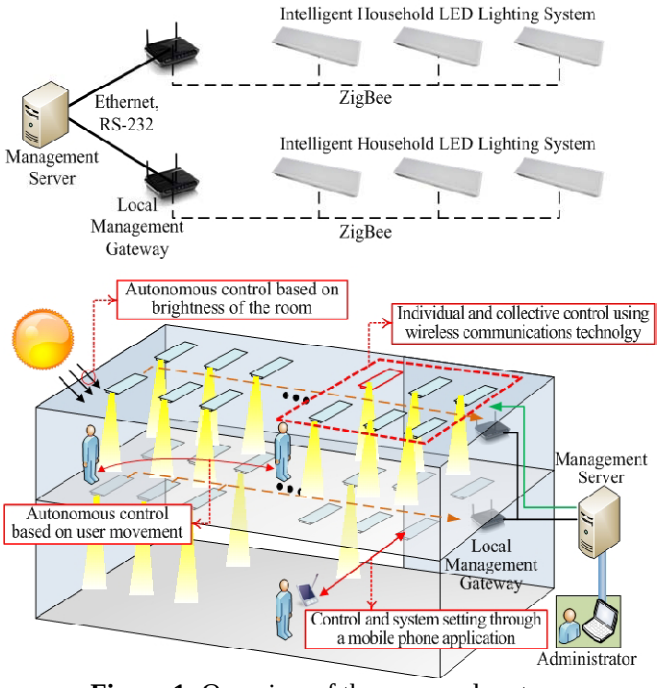

Figure 1: Overview of the proposed system

The proposed system basically controls illumination intensity of a lighting device according to user movement and brightness of surroundings. That is, when the maximum value of illumination intensity of a lighting device is *Lmax* and the minimum value is *Lmin*, the illumination intensity becomes *Lmax*, if user movement is detected and becomes *Lmin*, if user movement is not detected for certain period time. There are many people in a home and office building; thus, user satisfaction is an important factor in the light evaluation. In these places, *Lmin*is set according to the proposed minimum light intensity control algorithm. Generally, *Lmin* is set to the high value in these places.

B. Software Section

This is an Operating System (OS) on which all the software applications required for our design are going to be run. This OS is flexible to any user to operate and easy to understood. Accessing the soft wares and using them is very convenient to user. Or-CAD is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics. The µVision development platform is easy-to-use and it helps you quickly create embedded programs that work. The µVision IDE (Integrated Development Environment) from Keil combines design management, source code editing, program debugging, and complete simulation in one powerful environment. Code written in 'EMBEDDED C'.

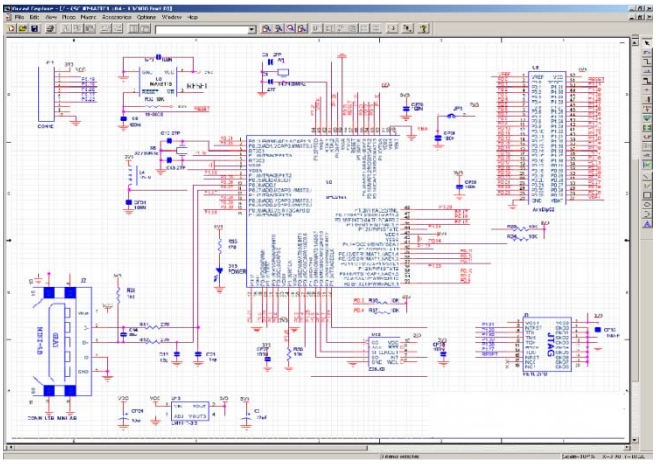

Figure 2: schematic design of the experiment by using ORCAD

The µVision3 IDE is a Windows-based software development platform that combines a robust editor, design manager, and makes facility. µVision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator.

3. Experimental Results

It is the module to possess the core function of the adaptive middleware. Basically, it is mainly used for the manager management, scheduling for managers, and access control of the table used by the managers. It registers and activates the managers upon receiving the control messages from the external management server. It also performs the role of deleting the existing managers in accordance with the commands transferred from the management server. In addition, it performs the role related to authentication for external management server. This group can registers and deletes the managers in the adaptive middleware group in real time. The illumination sensor manager performs the roles of gathering the value of intensity of illumination from the sensor or making the rule table for control upon receiving the data sensed from the sensor module, the neighboring lighting system, or the management server.

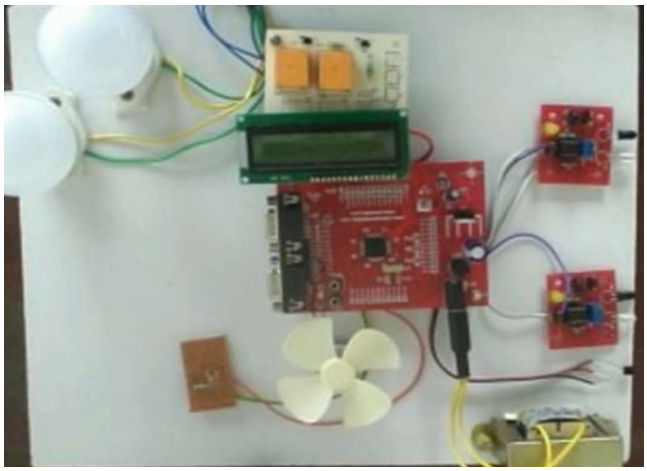

Figure 3: Experimental Kit

Intelligent wireless monitoring household LED lighting system considering different modules like LDR, LCD, microcontroller, IR sensors, LED lights etc.

Figure 4: Detect the object

The IR sensor detects which number of persons entering in the room or hall. Sending to the information to microcontroller. The person no is 0 then the LED lights are not glow. Room or hall exit side IR sensor detect the which number of persons are decrease in the room. Persons are decrease up to 5 persons then the second LED light is off only one LED light is on. Persons are decrease up to zero persons the LED lights are off state. Temperature sensor detects the temperature. The normal room temperature is 29 to 30 degrees. The room temperature increases up to 40 degrees then the temperature sensor detect the temperature then the ac or fans are automatically on.Room temperature decrease slowly up to 29 to 30 degrees automatically ac or fans are off.

Figure 5: Hyper Terminal Window

In the windowsxpversion .Click start next –click programs-click accessories-click communication-click hyper terminal-click ok. In the hiper terminal window giving the name and save the name. Next connect to windows in that windows connect wire com1-click ok.

4. Conclusion

Light accounts for approximately 20 percent of the world's total energy consumption; thus, a lot of studies and development related to energy saving of a light have beend one by various researchers all over the world. However, since there are no products considering both energy efficiency and user satisfaction, the existing systems cannot be successfully applied to home and office buildings. Therefore, we propose an intelligent household LED lighting system considering energy efficiency and user satisfaction. The proposed system utilizes multi sensors and wireless communication technology in order to control an LED light according to the user's state and the surroundings. The proposed system can autonomously adjust the minimum light intensity value to enhance both energy efficiency and user satisfaction. We designed and implemented the proposed system in the test bed and measured total power consumption.

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