Review on Energy Efficient Intelligent Lighting System

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Abstract-The most energy waste is caused by the inefficient use of the consumer electronics, in a light accounts. This paper introduces a new LED Lighting Control System designed to reduce energy consumption. This system allows automatic control of household lighting system through situation awareness such as user movement or the brightness of surrounding. For increasing the efficiency of lighting system, we briefly discuss the various energy saving solutions. The proposed system use multi sensors and wireless communication technology in order to control an LED light according to the user’s state and the surrounding light illumination. The proposed system provides high energy efficiency and user satisfaction as compared to that of the existing lighting system in market.

Keywords- Household lighting system, situation awareness, light illumination

I. INTRODUCTION

Nowadays energy saving has become one of the most important issues. For that energy saving solutions are essential in recent years. A light accounts for approximately 20 percent of the world’s total energy consumption [9]. Lighting control systems provide many benefits such as operational convenience, scheduled control, reduced energy consumption. Automated and intelligent lighting control is one of the important components in intelligent buildings. The invention of a light emitting diode (LED) is reducing the energy consumption of a light. The LED lighting device consumes half of the energy consumption compared to the fluorescent lighting device [2]. Also LEDs are highly efficient, with lower maintenance, directional, safer technology, fast operation.

Intelligent Lighting Systems is new to lighting, apply networking and software based intelligence to increase the energy efficiency benefits of LED-based light. The result is a lighting platform that gives provision to manage never before experience of levels of energy efficiency, improves the standard of the light delivered and provides additional capacity that continually enhance operational efficiency.

These days an intelligent lighting control system using various sensors and communication modules which are actively studied and developed. The existing lighting control systems can support only simple light on/off or dimming according to user movement or brightness of surroundings; it is difficult to apply to complex environments such as house or office. It is difficult to apply because variety of controls required. These systems are mostly installed in the places such as the front door, warehouses. The existing systems are designed without considering user satisfaction, it is not suitable for the places such as house and office where user satisfaction is more important than cost benefits due to energy saving.

The proposed system used multiple sensors includes movement sensors such as Passive infra-red (PIR), daylight sensors and timers and wireless technology in order to control LED light according to user state and outside light. This system autonomously adjusts the minimum light intensity. Typically user wants different light intensities in different places. Sometimes surrounding light is sufficient and no need to on light. Or sometimes user forgot to turn off light. These factors cause waste of electricity, so power management is necessary in order to save energy. Intelligent Lighting system not only offer electricity savings, but also they can improve comfort, reduce maintenance costs and impart greater flexibility to the use of a workspace. In this paper, we take review of an intelligent LED lighting system with maximum utilization of LED, system with communication capability, situation awareness and enhance energy efficiency and user satisfaction.

This paper is organized as follows: in section II we discuss Literature Review of intelligent LED lighting system; in section III we discuss Proposed Intelligent Lighting System; in section IV conclude intelligent LED lighting system.

II. LITERATURE REVIEW

In this section, we discuss the existing works about Intelligent Lighting system using the multi sensors and wireless communication technology. Fabio Leccese proposed Remote-Control System of High Efficiency and Intelligent Street Lighting Using a ZigBee Network [1]. This system can optimize management and efficiency of street lighting systems.
System uses ZigBee-based wireless devices which enable more efficient street lamp-system management. It uses a multiple sensors to control the system parameters. For transfer the information system uses ZigBee transmitters and receivers.

Jinsung Byun, Insung Hong, Byoungjoo Lee, and SehyunPark [2] proposed Intelligent Household LED Lighting System with Energy Efficiency and User Satisfaction. This system manages lighting devices according to user movement. Also, lighting control based on the brightness of the room. The control and the system setting through a wireless controller and android application. The minimum light intensity algorithm is proposed to meet the user requirement and energy saving. Design adaptive middleware platform to update an internal program through the automatic control or the remote control by an administrator in a manner conforming to the external environmental changes.

Jinsoo Han, Chang-Sic Choi, and IlwooLee [3] proposed More Efficient Home Energy Management System Based on ZigBee Communication and Infrared Remote Controls. The ZigBee hub has an IR code learning function and the IR remote control signal of a home device connected to the power outlet. The power outlets and the light in the room can be controlled with an IR remote control. This method reduces the standby power consumption. This system provides easy way to add, delete, and move home devices to other power outlets.

Chi-Huang Hung, Ying-Wen Bai, Wen-Chung Chang, Ren-Yi Tsai [4] proposed Home LED Light Control System with Automatic Brightness Tuning for The Difference in Luminous Decay. This system proposed software and hardware modules of an embedded board with a sensor and an interface circuit.

F. J. Bellido-Outeirino, J. M. Flores-Arias, F. Domingo-Perez, A. Gil-de-Castro, and A. Moreno-Munoz proposed Building lighting automation through the integration of DALI with wireless sensor networks. This system is the integration of Digital Addressable Lighting Interface (DALI) devices in wireless sensor networks [5].

JinSung Byun, BongjuJeon, Junyoung Noh and YoungIlkim proposed An intelligent self-adjusting sensor for smart home services based on ZigBee communications. This system have situation based self-adjusting scheme, an event-based self-adjusting sensor network, hardware and middleware implementation. Some smart home services are also introduced using this system [6].

Y-W Bai et al proposed a design and implementation of home embedded surveillance system with ultra-lowpower [7]. This design use piezoelectric infrared sensor and pressure sensor. These sensors wake up the MCU which is having power management for sensors. This system also uses majority voting mechanism to manage and increase probability of sensors.

Ying-Wen Bai and Yi-Te Ku proposed Automatic room light intensity detection and control using a microprocessor and light sensors [8]. In this system, microprocessor, RF module and light sensors are used. Multiple home light control modules are used, which transmit and receive data from each other through RF module.

### III. PROPOSED INTELLIGENT LIGHTING SYSTEM

Intelligent Lighting Systems having combine aspects to achieve high levels of energy efficiency along with high-quality illumination and new control capabilities. By including LEDs, distributed intelligence and networking into a single system, Intelligent Lighting Systems (i.e., lighting from a fixed expense to a strategic asset. They also provide operational insight and intelligence reports, monitoring. The elements of the intelligent lighting system are: Intelligence, LEDs, sensors and networking. The core of an Intelligent Lighting System is a distributed control system, which is combination of sensor data and software-based ‘rules’. Software-based rules determine where and when to deliver light within a room. This intelligence has a great effect on driving down energy usage, ensuring that lights are only consuming power when needed. Intelligent Lighting Systems include sensing devices for ensuring efficient light delivery. These devices provide the ability to identify environmental elements; e.g., daylight, and adjust the delivery of light according to pre-defined software rules.

Bidirectional networking, this allows user to communicate with a centralized control device of an Intelligent Lighting System.

The proposed intelligent lighting system is with a PIR sensor, light illuminance sensor and with wireless communication technology. The proposed system controls the intensity of lighting device according to user movement and surrounding light. The main feature of proposed system is autonomous control based on user movement and intensity of light from outside, also user can control system through wireless technology, control and setting of system through a mobile phone application. The proposed system can reduce the energy consumption by interplay with user state and surrounding condition. Also user can control the light intensity according to his convenience through the mobile application. User can send the signal of inconvenience to the system through mobile phone application. The system is having three modes of working – Automated mode, switch “OFF” mode and switch “ON” mode.

The basic Block diagram of proposed system is shown in the Fig 1. By using arduino board we can develop proposed system. The motion sensors and the light sensors are connected to arduino board. The proposed system has a server control through serial...
wire communication. The mode of operations can be control by server. For remote monitoring and control a mobile phone application can be develop. The communication of mobile phone application is through wireless Bluetooth technology. User can easily control and monitor system from remote location.

Intelligent lighting system has operates in a distributed manner to provide autonomous control. Each individual controller adjusts luminance of the unit to meet the illuminance goal.

The intelligent lighting control sequence is given below:

1. Initialize the intelligent lighting system and provide minimum light illuminance at each sensor locations.
2. Each illuminance sensor detects the current light luminance.
3. Each illuminance sensor communicates its target illuminance level and current light illuminance to the network.
4. Controller of each intelligent lighting unit controls light luminance found on the current and target illuminance of each sensor with the aim of minimizing power consumption while achieving target illuminance.
5. Repeating steps 2 thru 4, the system continuously senses environmental condition, and adjusts parameters so that goals are achieved

Using the above process, intelligent lighting system can autonomously control lighting to satisfy energy saving goal. Continuous sensing of environmental information allows intelligent lighting control system to respond quickly to changes such as addition or movement of illuminance sensors and addition or malfunction of lighting fixtures.

A. Comparison of existing system with proposed system

Table I: Comparison of existing system with proposed system

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<thead>
<tr>
<th>Existing System</th>
<th>Proposed System</th>
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<tr>
<td>1. Highest operating costs</td>
<td>1. High operational cost</td>
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<td>2. The systems are difficult to install and with high maintenance.</td>
<td>2. The proposed system is easy to install and with low maintenance</td>
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<td>3. No user satisfaction and energy efficiency</td>
<td>3. Proposed system gives user satisfaction and energy efficiency using easy monitoring</td>
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<td>4. Difficult to control setting time.</td>
<td>4. The ability to easily control setting time.</td>
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<td>5. Difficult to match with the control that allow user to tune the light level</td>
<td>5. Easily match with the control that allow user to tune the light level</td>
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<tr>
<td>6. The ability to change control setting over time</td>
<td>6. The ability to change control setting over time</td>
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<tr>
<td>7. No dimming option</td>
<td>7. Wide range of dimming option</td>
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These limitations of reviewed system can be overcome by making some changes in the existing system. The proposed system provides user satisfaction and energy efficiency using easy monitoring: comfort and easy access to real-time information on energy consumption. The proposed system use low voltage high frequency supply unit at the distribution center to minimize the consumption. This system is easy to installed and integrate. It is easily installed at entrance part or corridor. This system requires less maintenance.
B. Applications for proposed system
This system is applicable at Home and office buildings. The system can be installed at entrance of home or office.
This system is very useful for libraries where lighting is very important. If there is no person detected system shut down lighting devices.
This system is also useful in Shopping mall, shops. This system can be used for Outdoor and infrastructure i.e., street lighting, lighting for industrial units, parking lot and storehouses, corridors.

C. Advantage of intelligent lighting system
Light regulation: System can continuous control light illuminance according to surrounding.
Intelligent dimmer: System can continuously sense surrounding light and adjust light illuminance
Delay control: When motion is not detected by sensors, all the light will automatically shut off without delay.
Remote monitoring and control: By using mobile application room light can adjust as per user convenience.

IV. CONCLUSIONS
Environmental issues like CO2 emissions, global warming are very important which are mainly caused by the excessive use of energy. The innovation of Light Emitting Diode significantly reduces this energy consumption. Many researches and development related to energy saving of a light have been done across the world. Since there is no one system gives energy efficiency and user satisfaction. There are some limitations with existing system. The proposed system use multi sensors and wireless communication technology in order to control an LED light according to user’s state and outside light. The system beat the inconvenience of users caused by automatic control of appliances just by selecting mode of operation of system. The system can also be applicable to various loads like pressure, force and etc.

References