ISSN: 2321-8169
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# Domestic and commercial LED Lighting system considering low power consumtion using intellctual property.

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***Abstract***— Saving energy has become one of the most important issues these days. 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 Various light control systems are introduced in current markets, because the installed lighting systems are outdated and energy-inefficient.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 Domestic and commercial LED Lighting System Considering low power consumption using intellectual property. 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. Our main purpose is to provide the end consumer with an economical fully centralized system in which home appliances are managed by an IEEE 802.15.4-based wireless sensor network. Not only is it necessary to focus on the initial investment, but maintenance and energy consumption costs must also be considered. This paper explains the developed system along with a brief introduction to usual building automation protocols. The proposed LED lighting system reduces total power consumption of the test bed up to 31%1.

***Index Terms*** *— minimum light intensity control, Building Automation, DALI, Wireless Sensor Networks, IEEE 802.15.4.*

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## I. 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.

As it was previously stated, building services are usually controlled separately, making BA the set of control and communication technologies which link those different subsystems and make them work from a centralized monitoring and control center [16]. The main purpose of having a single control point which provides access to all building services is the costs reduction. A remote monitoring allows the quick detection of failing devices without needing long searches and wasting personal time. This continuous monitoring enables a preventive, or predictive as well, maintenance, which results in a reduction of operational and maintenance costs. Since it is estimated that the operational cost of a building is about seven times the initial investment, taking into consideration the global life-cycle an additional initial cost is worth the effort [15].

The need of a centralized monitoring control center makes necessary the integration of all BA applications. The number of proprietary solutions has increased since the beginning of BA, but now we have several open standards (BACnet, LonWorks, KNX, DALI, ZigBee…) which make the integration process easier. Our work focuses on the development of a prototype to be used in a wireless sensor network (WSN) which also integrates DALI protocol. Since DALI is a well-established standard and it has been adopted by major electronic ballasts' suppliers it is very easy to find DALI compliant devices. Despite it is designed for lighting control, DALI has also been adapted to other applications, such as motor or fan controllers, proximity alarms, etc. [17]. Adapting the standard to a WSN allows integrating DALI devices as a part of the WSN, expanding the traditional DALI bus and removing wires (DALI devices require a dedicated bus for data transmission),

which results in a reduction of installation costs. A WSN as part of a home automation system is also known as a wireless home automation network [18], it allows monitoring and control applications for home end user and energy efficiency.

All things considered, design goals of the new intelligent lighting control system are as follows:

- The new intelligent lighting control system should be designed to *maximize the utilization of an LED.*
- The new intelligent lighting control system should be designed to *have the communication capability.*
- The new intelligent lighting control system should be designed to *control based on the situation awareness.*
- The new intelligent lighting control system should be designed to *enhance both energy efficiency and user satisfaction.*

Therefore, 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.

## II. PROPOSED SYSTEM

We design the Domestic and commercial LED Lighting System Considering low power consumption with a motion detection sensor, illumination sensor, and wireless communication interface. Before presenting the proposed system with system architecture and important scheme.

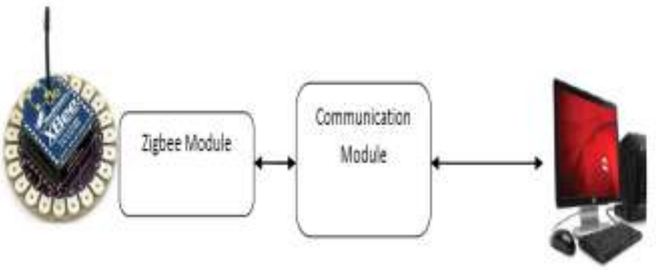


Fig .1. Basic transmitter block diagram of the proposed system.

As for the conventional LED lighting products, they should be developed using the low-cost MCU in order to reduce the production unit price; thus, they have a disadvantage of having the limited availability of the computing resources or storage resources. To solve this problem, we design the platform of adaptive middleware that can update an internal program through the automatic control or the remote control by an administrator in accordance with the external environmental changes.

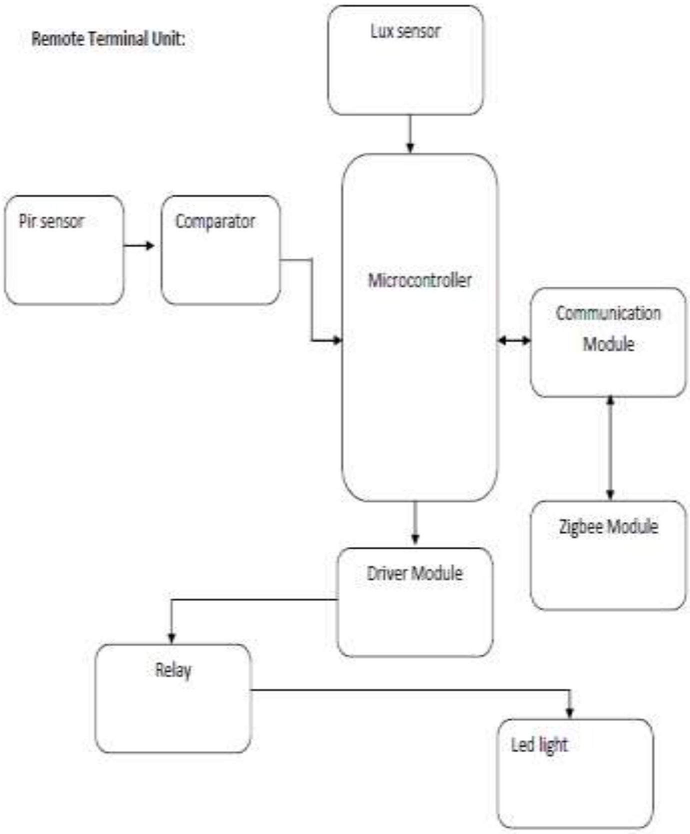


Fig .2. Basic receiver block diagram of the proposed system.

Above fig.2. show the block diagram of intelligent household led lightning system in receiving section the ARM7 LPC2148 Microcontroller perform all input and output controlling operation. The function of pir sensor trigger the microcontroller when human present.

The adaptive middleware platform is composed of *the LED control module group*, which performs the role of controlling LED, *the adaptive middleware group*, which can change through the external environment or the remote command of the administrator, and *the table group*,

*Network Module*: It is the module related to the ZigBee and RS232 serial for communication with the external control system. This module processes interrupts and message for communications.

*Manager Module*: It internally processes the control command, which is transferred from the manager of the adaptive middleware group and converts it into a form for communications and control, and has the role of managing the conflict or loss of the transferred messages.

*PWM Module*: It performs the role of generating and stabilizing the PWM signal for LED control. It also performs the role of generating the signal to control an actual LED based on the data transferred from the adaptive middleware and retrieved from the table group.

 ISSN: 2321-8169
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**Basic operation proposed system**

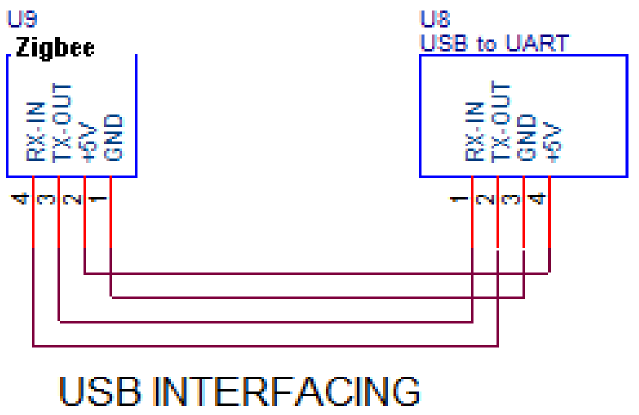


Fig .3. transmitter circuit diagram of the proposed system.

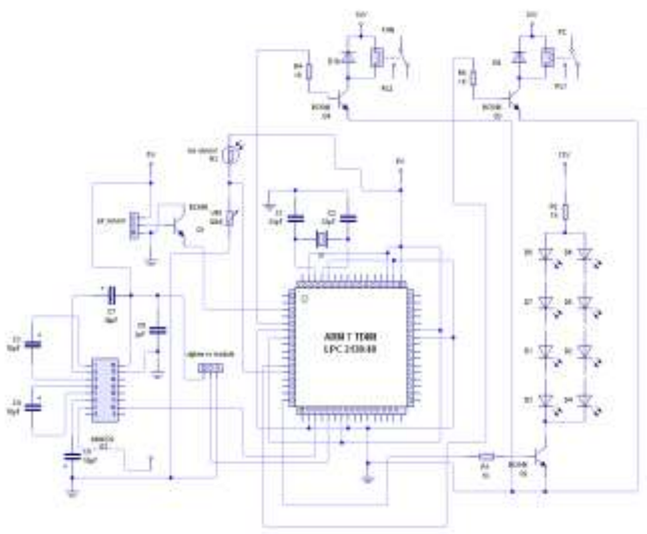

Fig .4. circuit diagram Receiver of the proposed system.

### Implementing the DALI WSN Controller

DALI is based upon the master-slave principle; the master

sends messages (frames) to any slave device in the system. Those messages contain an address and a command, thus only the addressed ballast will react to the message. A message sent by the master is called a forward frame; it consists of 19 bits at 1200 bps using a bi-phase encoding (Manchester Differential). The first bit is a start bit, the next 8 bits are the slave address and the next 8 are the command.

There last two stop bits are not in Manchester code. There are query commands that make the DALI device enter into active mode and send a backward frame to the master, this is an 11 bits frame with the same characteristic than the forward frame, one start bit, 8 bits with the data response (status, actual level, etc.) and two stop bits. In the address byte of the forward frame only six bits are used for individual addressing. The address byte has the following structure (each letter represents a single bit): YAAAAAAS, where Y takes the value '0' when a short address is used and the value '1' for a group address or broadcast; A is the significant address bit and S is '0' when the command is a direct level command (e.g. a dimming value or a speed rate) or '1' when it is a DALI command. A master can only have 64 slaves as it can only address 64 directions (six A bits). This last concern can increment DALI installation cost in large buildings, since we need different loops to control more than 64 devices individually.

Our approach consists of implementing a DALI master controller using an IEEE 802.15.4-based WSN. Nodes which compose the WSN have a microcontroller unit (MCU) and an IEEE 802.15.4-compliant transceiver. The DALI communication protocol is implemented in the MCU. In our system we have the DALI devices as slaves and the nodes as masters, controlled by the personal area network PAN coordinator attached to a PC host. The coordinator accesses to any DALI device using the node MAC (8 bytes) or network (2 bytes) address instead of the DALI slave address, enhancing the number of connected devices. With this process we also skip the long DALI address allocation process.

## 1. SOFTWARE

For developing or testing an embedded system application, a particular development cycle is followed which consists of several stages. An Integrated Development Environment (IDE) allows for implementation of all such steps of a development cycle.

Typically, a development cycle has following steps:

- The code is written/edited in an Editor program.
- The Compiler/Assembler/Linker programs generate relevant support files like .hex, .obj etc.
- The code is loaded into Simulator/Debugger program.
- d. The code is analyzed by Simulation or Debugging.
- If an error occurs, the code is re-edited and the whole cycle is repeated.

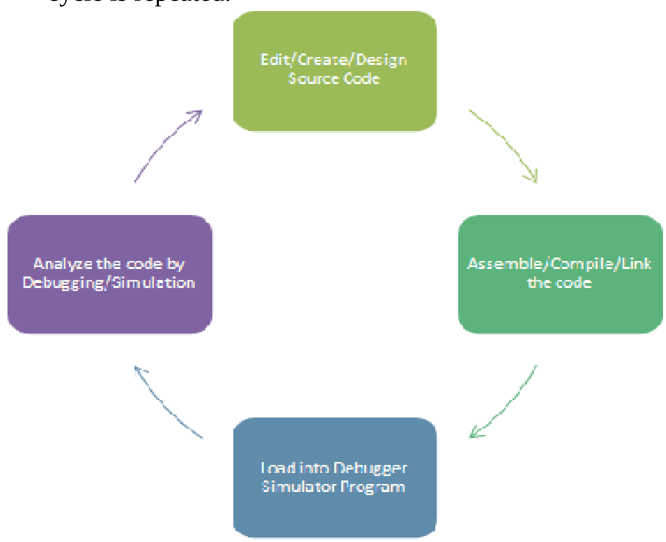


Fig 6 :Development cycle by IDE

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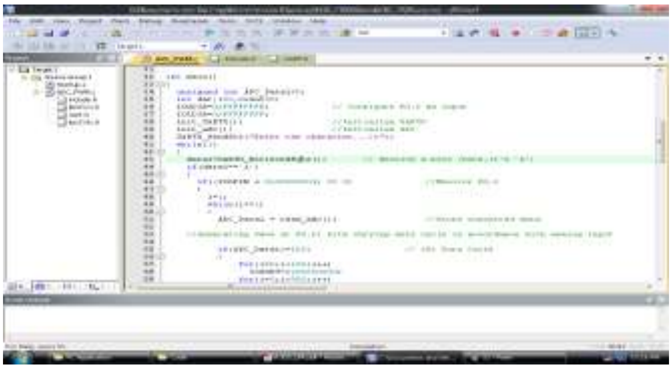

Fig. 5. Keil compiler screen shot

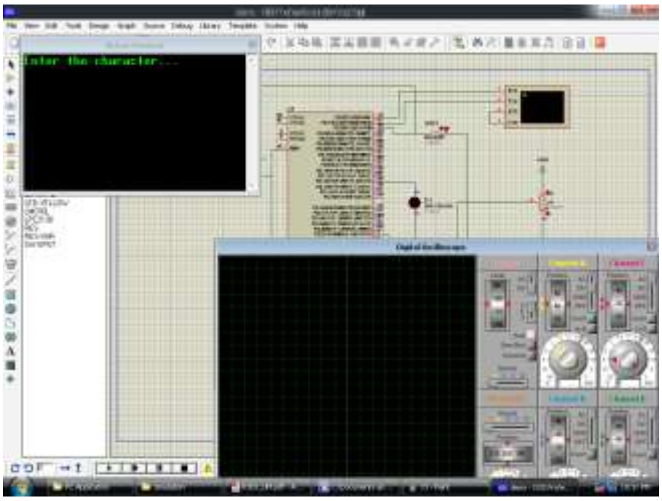

Fig 6. Protius simulation of proposed system

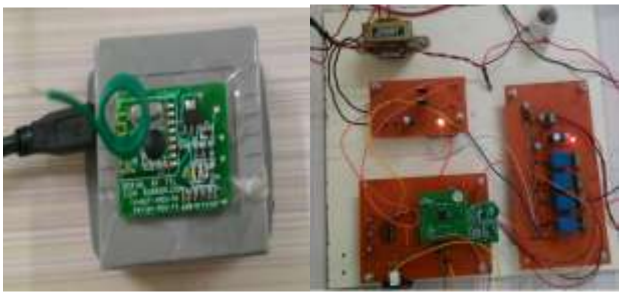

Fig. 7. Implementation of the proposed system; (a) prototype, (b)installation.

## CASE STUDY AND EXPERIMENT

*A. Case Study*

*1) Home and office building*

There are many people in a home and office building; thus, user satisfaction is an important factor in the light evaluation. Intelligent Household LED Lighting System Considering Energy Efficiency and User Satisfaction 75 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.

*2) Warehouse*

There are a few people in a warehouse; thus, user satisfaction is a less important factor than the case of a home or office building. Generally, in the warehouse, *Lmin* is set to the low value. In this case, a significant amount of energy consumption can be reduced.

*3) Parking lot*

Like the warehouse, in the parking lot, user satisfaction is an less important factor than the case of a home or office building as in a warehouse. A car that enters the parking lot will move a vacant parking space; thus, when a car enters the parking lot, *Lmin* is set to the high value only from the entrance of the parking lot to a vacant parking space. Then, when a user gets out of a car, *Lmin* is set to the high value only from user's current position to the entrance of the building.

*B. Experiment and Results*

In an experiment, we measured total power consumption for 14 days. Fig. 8 shows the result of an experiment. The proposed lighting control system reduces energy consumption up to approximately 29%.

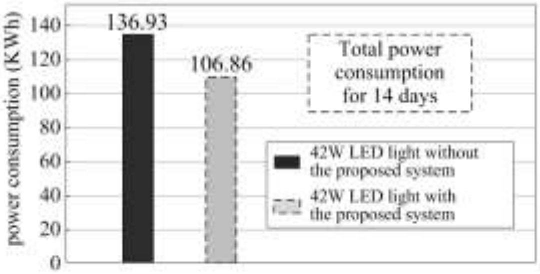


Fig. 8. Floor plan of a test bed with the illumination simulation result.

## III. CONCLUSIONS AND FUTURE WORKS

Saving energy has become one of the most important issues these days. A 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 been done 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.

The proposed lighting system reduces total power consumption of the test bed up to 29%

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