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Review on Design and Implementation of Energy Efficient Domestic LED Lighting System

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ABSTRACT:
This paper introduces a new LED Lighting Control System designed to reduce energy consumption of Domestic appliances using multi sensors and wireless technology. The system allows automatic control of household appliances like lamps, fan, etc. 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 provides high energy efficiency and user satisfaction as compared to that of the existing lighting system.

Keywords: Energy management, home automation, minimum light intensity control, situation awareness.

I. INTRODUCTION

Lighting is the most visible form of electricity consumption. We need secured, affordable and environmentally sustainable energy because of environmental problems such as climate changes and global warming, etc. caused by excessive use of energy. Lighting control systems provide many benefits such as operational convenience, scheduled control, reduced energy consumption and moderation of peak demand. Automated lighting control is one of the important components in intelligent buildings and green buildings. Modern lighting control systems have evolved from hardwired circuits and analog signals into flexible digital solutions, and many intelligent technologies have been proposed for digital lighting control systems. Lighting controls not only offer electricity savings, but also offer further benefits depending on the application they can improve comfort, reduce maintenance costs and impart greater flexibility to the use of a workspace. Lighting controls are best deployed as a reliable means of turning off the lighting. People will turn lights on when they need them, sometimes they forget to turn them off. There are some effective devices that control the automatic switching on and off of lights. These include movement sensors such as Passive infra-red (PIR), Ultrasonic or Microwave, daylight sensors and timers. By increasing the efficiency of lighting system, there can be significant energy saving and reduction in peak load. There is a scope for reducing about 30 to 35 % of the morning and evening peak demand. The management of the energy consumed in households is nowadays recognized as a key issue toward CO_2 emissions reduction and optimal use of natural energy resources. The energy reservation concept presented in this article offers an automated yet proactive way of controlling the energy consumed in households through the real-time management of the contained appliances, whether they are in active or standby state.

In recent years, usage of LED lights has been increasing. As interest of energy saving broadens, light power consumption, which are one of the highest power consumption, and becomes a big issue. At this point, LED lights will be the most practical answer to decrease power consumption in a home or building. Moreover, LED technology has been researched by many companies and research centres with advanced countries as the centre, and now it can be substituted for the existing lights. There are various types from low power to power LED, and it is expected that it will influence lighting markets seriously. LED has a variety of advantages compared with the existing lights. First of all, it is easy to interwork with other electronic modules such as sensors and communication module to provide new services, and can be controlled more elaborately because LED is a kind of electronic components.

In this paper, we design an intelligent LED lighting system which is suitable for household appliances and implement it to verify its energy efficiency compared with the existing lights. Because of this limitation of existing systems, a new intelligent lighting control system is proposed to be designed considering both energy efficiency and user satisfaction.

A. Paper Organization

The rest of the paper is organized as follows: section II discusses related work and also investigation of Intelligent Household LED Lighting System based on multi sensors and wireless communication technology. Section III discusses

some limitations with respect to existing Lighting systems and also how to workout different remedial measures to mitigate it. Section IV concluded and discuss about the future work.

II. LITERATURE REVIEW

In this section, we briefly discuss the existing works about Intelligent Household LED Lighting system based on the multi sensors and wireless communication technology.

Andreas Foglar, Halid Hrasnica, Maurice Draijer, Nikolaos Mouratidis, Spyridon Tompros [1] proposed an architecture designed for Network Energy Technologies for Green WAS provides the home appliances an ability to maintain total energy consumption within User-Defined limits.Energy Consumption of the appliances set in standby mode can be avoided using KNX Power line communication interface. Proposed Energy consumption estimation Methodology is applicable to both instantaneous and steady energy consumption.

Haesik Kim, Honggang, Kari Horneman, Zhang Tao Chen, Yang Yang [2] suggests network energy saving technologies for Green Wireless Access Network focused on the LTE system to study the energy efficiency (EE) of the wireless access n/w, which is broadly defined as any wireless system using Radio Base Stations (RBSs) or access points (AP) to interface mobile devices with the core network or internet. Classifying the n/w energy saving technologies into time, frequency and spatial domains, the main solutions in each domain are described briefly. Proposed technology is mainly focused only on solutions involving a single radio base station.

Jinsung Byun, Sehyun Park [3] developed a Self-adapting Intelligent System which consists of Self-adapting Intelligent Gateway (SIG) and Self-adapting Intelligent Sensor (SIS) in order to make the consumer devices more energy efficient and intelligent along with the Efficiency Self-clustering Sensor Network (ESSN) and Node Type Indicator Routing Protocol (NTIR) which are introduced to enhance service response time and network lifetime. The middleware inside microprocessor memory is dynamically reconfigured and modified to enhance QoS such as the service response time, hit ratio, situation analysis and the energy saving performance.

J.Han, C.S.Choi and I.Lee. [4] proposed a Home Energy Management System (HEMS) based on ZigBee Communication and IR remote control system reduces and manage home energy more efficiency by reducing active standby power and controlling the power outlets using ZigBee Hub with IR code learning function. Proposed HEMS provides a mapping function between the Power outlets and home devices by use of 4 bytes network node ID. Some type of uneasiness may also be created by this system like if the users may want low intensity of light, for some situation but the system will cut the power off leading to darkness.

Cagdas Atici, Tanir Ozcelebi and Johan J. Lukkien [5] proposed an User-Centered Intelligent Road-Lighting Design executing light dimming commands automatically using contextual information extracted from sensory data. Proposed architecture consists of a central terminal and several controllers which uses Power Line Communication for sending commands for sending commands to the Luminary Poles. The PLC infrastructure allows the system to do experiments only at pedestrian speeds not in vehicular speeds.

Fabio Leccese [6] presents a Remote-Control System of High Efficiency and Intelligent Street Lighting using a ZigBee Network of Devices and Sensors providing a high efficient and Intelligent Street Lighting. Here highly efficient LED technique supplied by renewable energy of solar panels allows the control system switching on the light only when necessary, increasing the lamp's lifetime so lets the system be suitable for street lighting in urban and rural areas when the traffic in low at a given range of the time.

M.S.Pan, L.W.Yeh, Y.A.Chen, Y.H.Lin and Y.C.Tseng [7] presented A WSN based intelligent light control system considering user activities and profiles in which wireless sensors are responsible for measuring current illuminations and the lights. The lights are controlled by applying the model of user's actions and profiles for indoor environments, such as a home for a reduction in energy consumption.

Byoungjoo Lee, Gwanyeon Kim, Insung Hong, Sehyun Park, Yoonsik Uhm [8] designed and Implemented a power aware LED light enabler with light sensors, motion sensors and network interfaces which communicates with context- aware middleware using an intelligent power gateway that adoptively determines the optimal power control by analyzing user living patterns. The proposed middleware facilitates the learning mechanism which analyzes the illumination and the user activity and controls the LED lights only when users exists around the devices.

Seung-Ho Hong,Tae-Jin Park [9] carried out an experimental Case Study of a BACnet-Based Lighting Control System providing benefits in building management and stable operation of the control system is guaranteed below a certain threshold of network traffics. The experimental model integrates daylight and fluorescent lighting environment. The hierarchical structure of the BACnet building automation system provides extensibility, flexibility and scalability.

Aurora Gilde-Castro, Antonio Moreno-Munoz, Francisco Domingo-Perez, Francisco Jose Bellido-uteirino, Jose Maria lores- Arias [10] presents Building Lighting Automation through the Integration of DALI with Wireless Sensor Networks which allows a half-duplex communication which can provide many parameters about the lighting and lamp status. DALI Devices require a dedicated bus for data transmission which results in a reduction of installation cost.

Schoofs, A. Guerrieri, A.G. Ruzzelli, G.M.P. O'Hare [11] presented an Automated electricity data annotation using wireless sensor networks to reduce the human supervision in Automatic Load Monitoring (ALM) systems consists of deploying a temporary wireless sensor nodes attached to each appliance. The System using a temporary (WSN) generates the sensor data to autonomously annotate data during system calibration. The system plays major role in appliance load monitoring. Using automatic annotation, we are able to annotate complex loads over long periods.

Ying-Wen Bai and Yi-Te Ku [12] proposed the Home Light Control Module design using a microprocessor and a light sensory for automatic room light detection and control. Presence of human body is sensed by the PIR sensor and accordingly the change of light intensity in a room is sensed by light sensor in the HLCM. Here RF module is used to communicate among the HLCMs to pre-control the lights achieving a high efficiency in home power management.

R.A.Ramlee, M.H.Leong, R.S.S.Singh, M.M.Ismail, M.A.Othman, H.A.Sulaiman, M.H.Misran, M.A.Meor Said [13] presents the design of Home Automation System (HAS) with low cost wireless remote control to assist and provide support in order to fulfill the needs of elderly and disabled in home.The main control system implements wireless Bluetooth technology to provide remote access from PC/laptop or smart phone. The design remains the existing electrical switches and provides user interface indicating the real time existing switches status. The system intended to control electrical appliances and devices in house with relatively low cost design, user-friendly interface and ease of installation.

Noriyuki Kushiro, Shigeki Suzuki, Masanori Nakata, Hideki Takahara and Masahiro Inoue [14] developed a Home Energy Management System (HEMS) using Low cost and highly reliable Residential Gateway Controller (Residential G/W) with Plug &Play mechanism. Appliances connected with a network make possible to use and to compose functions on different home appliances. Optimized interlocking controls and power leveling controls are realized by utilizing information from Internet such as weather and temperature information.

Hayoung Oh, Hyokyung Bahn, and Ki-Joon Chae [15] presented a new sensor routing scheme Relative Direction based Sensor Routing (RDSR) that provides energy-efficient data delivery from sensors to the home base station. The proposed scheme divides the home area into sectors and locates a manager node to each sector which receives collected data from sensors and delivers the data to the base station through the shortest path of the 2-dimensional (x, y) coordinates. The performance gap between RDSR and CR (Conventional Routing) becomes wider as the number of sensor nodes increases, which implies that RDSR is more scalable than CR, so the RDSR reduces energy consumption significantly compared with the conventional broadcasting based routing scheme.

Jinsoo Han, Haeryong Lee, and Kwang-Roh Park [16] proposes remote-controllable and energy-saving room architecture to reduce standby power consumption and to make the room easily controllable with an IR remote control of a home appliance. By using IR code learning functionality, the ZigBee controller can assign a certain IR code of a remote control of a home appliance to the power outlet or the dimming light. A user can control the power outlets and the dimming light with an IR remote control of any home appliance. Proposed room architecture provides the remote-controllable and energy-saving room.

Young-Sung Son, Topi Pulkkinen, Kyeong-Deok Moon and Chaekyu Kim [17] describes a home energy management system based on power line communication that can provide easy-to-access information on home energy consumption in real time, intelligent planning for controlling appliances, and optimization of power consumption at home. Smart metering and power line communication can provide detailed information of energy consumption patterns and intelligent controlling to appliances at home. Especially, planning makes to shift device controlling on peak price time and to smooth power demand work load providing benefits about resource utilization, energy conservation and cost reduction to users.

Cheng-Hung Tsai, Ying-Wen Bai, Chun-An Chu, Chih-Yu Chung and Ming-Bo Lin [18] presented a way to reduce the standby power of a socket. The socket supplies appliances with power when the user turns them on. System design uses an MCU, receives signals from a PIR sensor which detects the user approaching the socket. The MCU controls the SSR On/Off when used as an appliance switch for shutting off the standby power. The PV array is added in design to reduce the consumption from the local electric power company.

Nagender Kumar Suryadevara, Subhas Chandra Mukhopadhyay, Sean Dieter Tebje Kelly, and Satinder Pal Singh Gill [19] presented a design and develope a smart monitoring and controlling system for household electrical appliances in real time. The system principally monitors electrical parameters of household appliances such as voltage and current and subsequently calculates the power consumed. The novelty of this system is the implementation of the controlling mechanism of appliances in different ways. The developed system is a low-cost and flexible in operation and thus can save electricity expense of the consumers. The developed system is robust and flexible in operation.

Ksh. Priyalakhsmi Devi, Amit Kumar Rohit, Satish Kumar Yawale, Dr. Saroj Rangnekar [20] developed a model for reducing the wastage of electricity due to careless and improper switching in households, schools, colleges and offices etc. It saves energy by maximizing the use of daylight. This is an automatic system which employs solar energy through PV. The system is capable of controlling lights, fans and air conditioners in a room depending upon various parameters such as LUX level, room temperature and motion. All these parameters are measured through various sensors and the controlling is done by microcontroller. This model itself consumes very low power and helps in saving a significant amount of energy. The model can be applied to government offices, private firms, residential buildings, schools, colleges etc. so as to avoid the wastage of electricity and maximum use of day lighting, also reduces our dependence on conventional energy and will help in conserving energy.

Insung Hong, Jisung Byun, and Sehyun Park [21] proposed the LED lighting systems for a parking lot provides energy efficient management by turning on and off LED lights according to vehicle's movement through a route prediction algorithm. Moreover, this system includes two types of sensors, illumination and motion detection, and ZigBee communication, and analyzes vehicle movement to turn on and off the minimum number of LED lights.Based on the two sensor information, the lighting system decides to turn on or off the lights in the expected route where a car will enter to save needless power consumption. However, in the first experiment for the practical users, the system could not predict a driver's route and considers it as an exceptional event at higher rates than the others. It is assumed that this is caused by

various drivers' patterns and size of vehicles. To complement this error, the algorithm should be improved to include driving patterns and complement response and processing time of the ZigBee network.

III. LIMITATIONS AND FUNCTIONS

The above Intelligent Household LED Lighting system have some limitations such as: (1) The system is not portable.(2) The system is not applicable to different consumers because energy control is based on fixed threshold power consumption. (3) Limited number of household appliances can be controlled because the power consumption control mechanism is limited to situation awareness like illuminance, room temperature, etc.

Overcome of limitations:
These limitations can be overcome by making some changes in reviewed system, like in first case provide user satisfaction and energy efficiency using easy monitoring: comfort and easy access to real-time information on energy consumption. To minimize consumption use low voltage high frequency supply unit at the distribution centre.

Functions of Intelligent Household LED Lighting System:

- Maximise the utilization of an LED.
- Have the communication capability.
- Automatic control based on situation awareness.
- Control and system setting through a wireless controller and a mobile phone applications.
- Reduce energy consumption via interaction with the information about user's state and surroundings.
- To enhance both energy efficiency and user satisfaction.

IV. CONCLUSIONS AND FUTURE WORK

Environmental problems like CO_2 emissions, global warming are very important issues which are largely caused by the excessive use of energy. The invention of Light Emitting Diode (LED) significantly alleviate this energy consumption. The proposed system utilizes multi sensors and wireless communication technology in order to control an LED light according to user's state and the surroundings. The system overcomes the inconvenience of users caused by frequent automatic control of appliances just by setting the threshold values according to space environmental characteristics (frequent or rare user movement, work type, etc).

Intelligence in the Energy Saving System allows them to be used anywhere in a process industries with little modifications in software coding according to the requirements. Using this concept, we can have the flexibility to adapt and extend, as the needs change. In future the energy saving system will be developed using wireless network. The system can also be applicable to various loads like applicable to various loads like pressure, force and etc. by increasing the number of ports of the micro controller.

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