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IMPLEMENTATION OF HOME LIGHTING SYSTEM USING PULSE WIDTH MODULATION TECHNIQUE AND ANALYSIS OF LOAD PRIORITY

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ABSTRACT

The most commonly used lighting system includes fluorescent lamps, incandescent lamps, Compact Fluorescent Lamps(CFLs)andLight Emitting Diodes (LEDs). Lighting systems using has become popular because of their attractive properties like long lifetime, less power consumption, more brightness and so on making them good enough to replace the most commonly used lighting systems. Having a way to reduce the brightness with respect to the daylight illumination will help in reducing the power consumption furthermore. This is done in the proposed system in which the brightness of the lighting system using LEDs as light source gets adjusted automatically by using an Algorithm named Illumination Decision Algorithm (IDA)where Pulse Width modulation (PWM) technique is used to reduce the power consumption to a considerable level and it is not available in the present lighting systems and the power consumption has been reduced to 43.695% by it. The consumption of the power is considerable more during the peak hours than normal hours mainly because of the usage of the consumer electronics by the consumers for various purposes. The proposed system helps in maintaining the stability of the network by means of using an algorithm called Load Priority Algorithm (LDA) to turn off the supply to the device consuming more power than the threshold value set.

Keywords

LED, CFL, IDA, LPA, PWM, HEM, LDR, PIR, lighting system and threshold value.

1. INTRODUCTION

Electrical energy is one of the types of energy used by people all over the world for various purposes using different consumer electronics. Because all the devices do not have the same amount of electrical energy consumption, the user requirement for each individual varies and the energy consumed varies depending on the devices being used. Lighting systems are the ones used to have illumination in a desired place. The maximum energy consumption is due the lighting systems.

Sources that provide lighting are of different types namely natural light source and man-made light source. The sunshine is the natural light source and it varies from the morning until evening and at night, there is no natural light source because of which man-made light sources were found. Over a period of time, light sources which work consuming electrical energy were developed which include incandescent lamps, fluorescent lamps, CFLs and LEDs. Taking into account the amount of energy consumed, the devices that consumes more energy were replaced with those consumes less energy so incandescent bulbs were replaced by fluorescent lamps and when CFLs were found, fluorescent lamps were replaced by CFLs. Now, LEDs are the light sources which replaced CFLs with their advantageous features like higher brightness, longer life time and lower cost than CFLs and hence, there is a switch over from CFLs to LEDs.

The maximum amount of power consumption is during the peak hours because all the users will perform their operation based on all electrical and electronic appliances thereby causing instability in the electrical network. If the loads i.e., the devices used are managed in an efficient way, this instability can be managed.

2. RELATED WORK

Research work is being done on the lighting system. Park *et al* [1] proposed a lighting system in which they have described about an energy-efficient system for reducing the wastage of power caused due to the inefficient use of consumer electronics. Multi sensors and wireless communication technology were used to control the LED lighting according to the user requirements and the proposed LED lighting system can autonomously adjust the minimum light intensity value to enhance both energy efficiency, and user satisfaction. Pan *et al* [2] proposed a light control system in which a WSN-based intelligent light control system for indoor environments was proposed. Wireless sensors were used to measure the current illumination and two kinds

of lighting devices, namely whole lighting and local lighting were used to provide background and concentrated illuminations, respectively. Two requirement models namely binary satisfaction model and continuous satisfaction model were also proposed. A closed-loop device control algorithm was proposed to adjust the illumination levels of lighting devices. F. Leccese proposed a [3] remote control system that can optimize the management and efficiency of street lighting systems was proposed. A ZigBee-based wireless device was used for street light management. A sensor combination was used to control the desired system parameter; the information was transferred point to point by using ZigBee transmitters and receivers and was sent to control terminal to check the state of the street lamp and to take appropriate measures in case of failures. Delaney *et el* [4] proposed a system in which a wireless sensor network (WSN) was analysed as a viable tool and a wireless tool called LightWiSe (LIGHTing evaluation through Wireless Sensors) was proposed to evaluate lighting control system. Matta*et al* [5] proposed a design for saving electrical energy by controlling the intensity of artificial light to a satisfactory level and getting use of the day light when possible was proposed. The amount of power delivered to the lamp is controlled by Pulse Width Modulation (PWM) technique. Controller Area Network (CAN) was used a media for communication with the sensors and actuators used. Sachin Bhardwaj*et al* [6]presented a Solid State Lighting (SSl) system in order to have some features like higher energy efficiency, longer lifetime, better control of spectral, spatial, temporal polarization, and colour properties of light. The proposed system utilized LEDs to create a playground for user-light interaction. A novel model on a Wireless Sensor Network (WSN) was proposed. Light sensors and actuators in the WSN provided service for sensing illumination changes and dynamical adjustment of luminary brightness according the user preferences. Experiments were conducted for two key scenarios namely reading and watching TV and it was shown that the preferred illumination levels in an activity space can be achieved and maintained, irrespective of external light variations. Kuzlu*et al* [7] proposed a Home Energy Management (HEM) to realize the residential Demand Response (DR) in the small grid environment. That provided a homeowner the ability to automatically performed smart load controls based on utility signals, customers' preferences and load priority. The HEM's communication time delay to perform load control was analysed, along with its residential energy consumption. Kuzlu *et al* [8] proposed an intelligent HEM algorithm for managing high power consumption household appliances with simulation for demand response (DR) analysis. The proposed algorithm managed household loads according to their preset priorities and guaranteed the total hold power consumption below certain levels. A simulation tool was developed to showcase the applicability of the proposed algorithm in performing DR at an appliance level. The paper demonstrated that the tool can be analyse DR potentials for residential customers. PhaniChavali*et al* [9] proposed a distributed framework for the demand response based on cost minimization was proposed. Each user in the system could find an optimal start time and operating mode for the appliances in response to the varying electricity prices. The cost function was modelled for each user and the constraints for the appliances were also modelled. An appropriate greedy algorithm to help the users schedule the appliances was also proposed. In that, each user was required to have only the knowledge of the price of electricity, which depended on the aggregated load of the other users, instead of the load profiles of individual user. In order for the users to coordinate with each other, a penalty term in cost function was introduced which penalizes large changes in the scheduling between successive iterations. Numerical simulations were made to show that the proposed system would result in lower cost for the consumers, lower generation costs for utility companies, lower peak load and lower load fluctuations.

3. PROPOSED SYSTEM

In all the existing systems, the illumination is provided only with fixed level of illumination and due to inefficient load management, there is fluctuation in the electrical network. In order to overcome these problems, a system in which the control over brightness[4] and load priority is incorporated is proposed. Along with these features, to have lighting only in the places where there is user movementPassive Infrared Sensor (PIR) is used which will turn on the light only when there is any user movement[2]. The lighting system proposed uses LEDs as light source [1], [6].. Another concept called the load priority is implemented by having two different loads. One is the lighting system proposed and another is light source. A threshold value for the determining the overloading is set and is done by means of Load Priority Algorithm (LDA). When the power consumption of a load exceeds the threshold value, the user is given a warning and three chances are given to reduce overuse. If the power consumption reduces within in the number of chances given, the system continues to operate in the same manner as it was and if not, the supply to that load is cut. The disadvantage of the existing system is rectified in the proposed system, thereby, decreasing the power consumption by the consumers which is the main aim of the proposed system.

3.1 Proposed Algorithms

In order to achieve the above mentioned factors, two algorithms are proposed namely,

- Illumination Decision Algorithm (IDA)
- Load Priority Algorithm (LPA)

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which are explained briefly in the following sections.

3.1.1 Illumination Decision Algorithm (IDA)

This technique is used because the illuminations of the LEDs has to be controlled according to the output of the LDR. Hence, the LEDs should have an illumination period which can be high or low in accordance with the LDR value[3]. A threshold value is set based for the LDR value based on which the illumination provided by the LEDs gets adjusted with respect to the illumination provided by the natural source. The threshold value is set by observing the daylight illumination from the morning until evening[3]. The variation in the brightness is achieved by using PWM technique[1], [5]. A loop operation is performed in the proposed system to have a continuous check over the threshold value and when the lighting system turns ON and OFF in accordance with the daylight illumination the operation is done by using LDA and because of this, the brightness adjustment is made automated.

3.1.2 *Load Priority Algorithm (LPA)*

To have stability in the electrical network, LDA [7] is proposed. The voltage consumed by each device is taken into account and a comparison is made based on the threshold value to know which device is consuming electrical energy more than the threshold value[7] – [9]. The threshold value is set monitoring the voltage consumed by the devices considered.When the device consuming electrical energy more than the threshold value, a warning is given to indicate the user regarding the overuse and a wait operation is performed. If there is no reduction is the consumption of electrical energy, the supply to the device is cut and this operation is performed by the proposed algorithm.

3.1.3 *Flow Chart*

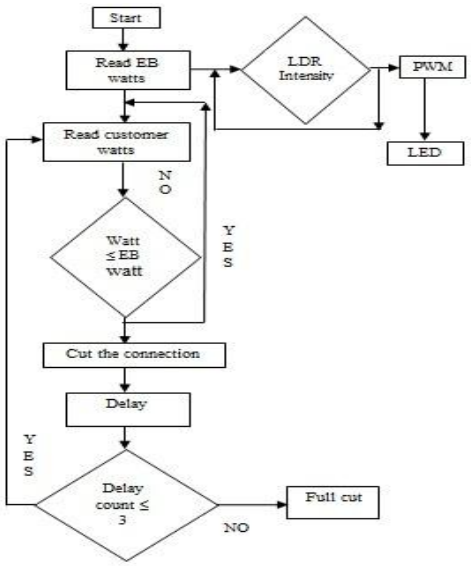

Fig 1: Flow chart of the proposed system.

LDR intensity represents the daylight illumination sensed by the LDR and in accordance with that PWM is generated by the microcontroller and is given to the lighting system which consists of LEDs and it is done by IDA. A maximum of three chances are given for the user to reduce the overuse of electrical energy by the device consuming voltage more than the threshold value if any and if the voltage consumptionhas not reduced within the given three chances, the supply to the device is cut which is done by LDA as shown in Fig 1.

3.1.4 Block Diagram

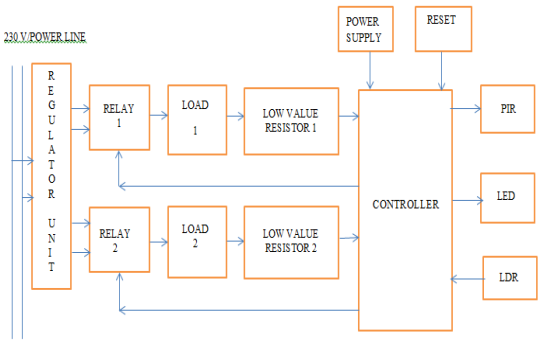

Fig 2: Block Diagram of the Proposed System.

Fig 2 shows the block diagram of the proposed system. The devices are connected to the controller via two relays so that when there is aoverload warning, the supply to the particular device can be cut. Here, two loads are used. One is the lighting system developed itself and another load is a DC motor. The low value resistors are used to measure the voltage consumed by each device and is fed to the controller to check the electrical energy consumption of each device continuously. In the lighting system, when the PIR detects any user movement, a signal is sent to the controller and the lighting system is turned ON. Depending on the LDR and the threshold value, the brightness provided by the lighting system varies and the process continuous automatically.

4. SOFTWARE AND HARDWARE DESCRIPTION

The software used to develop the proposed system is LabVIEW. It has various advantages and a few important things are

- Graphical Programming
- Ease of interfacing

The graphical program for the proposed system is developed and is interfaced with the hardware using a USB cable. The heart of the hardware is the Arduino UNO board. It was selected because LabVIEW supports third party hardware. The controller shown in the Fig 2 is the microcontroller in the Arduino UNO board, ATmega 328. The operating voltage is 5V. It has 14 digital I/O pins among which 6 pins are special dedicated for PWM output and there are 6 analog input

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pins. The operating clock speed is 16MHz. The default baud rate provided by Arduino UNO is 115200.

5. RESULT

The LDR, PIR and the voltage consumed are analog values and are given to the analog input pins. The voltage required to operate the Arduino UNO will be got by it from the USB connected to the system in which the programming is done. The PWM generated with respect to the LDR input value is given to the LED. Because of having threshold value, the device turn ON only after reaching that value which helps in reducing electrical energy consumption the and using PWM reduces the electrical energy consumption furthermore and a reduction of 43.695% in electrical energy consumption is achieved by this. The devices connected via the relays form the loads and the LDA performs the load priority stabilizing the electrical network. The real time hardware of the proposed system is shown in the Fig 3.

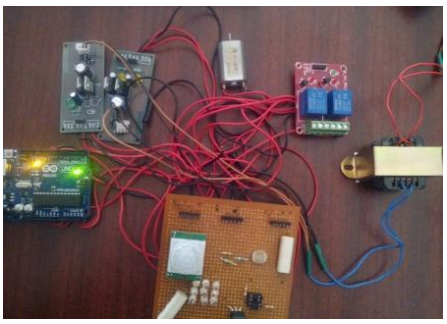

Fig 3: Hardware Module of the Proposed System.

6. FUTURE WORK

Wireless communication can be used to have an increase in the level of brightness if there is any in convenience for the user with the illumination provided by lighting system by using ZigBee module. The user can be given a remote to intimate the inconvenience to the microcontroller which in turn will generate an interrupt. Once an interrupt indicating the inconvenience experienced by the user, the illumination provided by the lighting system can be further increased.

7. ACKNOWLDEGEMENT

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BIOGRAPHIES

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