Building A Sustainable Future Using Smart Street Lights

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Abstract: With the advancement in science and technology, electric energy has become one of the essential means to carry out today's life. Power demand affects the life of people in many ways. With this sudden surge in the demand of power, it is important, rather essential, to find ways to conserve power to prevent resources from getting exhausted. The present paper focuses on one of the solutions for this problem, i.e. by building smart street lights which will reduce power wastage due to unnecessary lighting of street lights regardless of traffic density and at odd hours. Another method to save power using this technique is further elaborated in the paper as well.

Keywords – Power consumption, Power wastage, Power efficient street lights

I.INTRODUCTION

In a country like India, where people day in day out suffer problems due to power shortage, it is important to use it intelligently. Lighting systems, particularly within the public sector, are still designed as per the previous standards of reliability and they don't usually complement latest technological developments. Recently, however, the increasing pressure associated with the raw material prices and also the increasing social sensitivity to CO_2 (Carbon Dioxide) emissions are leading towards development of new techniques and technologies which permit significant cost savings and larger respect for the environment. There are three noted solutions to those issues. The first one, and maybe the most intuitive, is the use of recent technologies for the sources of light. The LED (Light Emitting Diode) technology is thought as best solution but it offers several edges. Researchers considered this, coming up with advanced street lighting system based mostly on LED. The second solution, and perhaps the most revolutionary, is to use of remote management system based mostly on intelligent lampposts that send info to a central management system, simplifying the management and maintenance. Researchers have developed street lamp system using the GPRS (General Packet Radio Service) transmission, power line carrier transmission or GSM (Global System for Mobile Communication). Finally, the third solution is to use renewable energy sources instead of typical power sources, therefore taking care of the environment. In this field, solar energy is the most often used resource. Unification of the three prospects, makes an intelligent lamppost managed by a remote controlled system that uses LED-based lightweight supply and is powered by renewable energy (solar panel and battery). The management is implemented through a network of sensors to gather the relevant info associated with the management and maintenance of the system, transferring the data in wireless mode using the ZigBee protocol (which has been chosen among numerous alternatives because it is the most convenient, see clarification below). The ZigBee remote sensing and management systems are widely described in the literature; we can cite here as examples the applications for the lighting systems [1].

II.METHODOLOGY

Street lamp controller is mainly consisted of the voltage/current collection module, illumination sensor, LED driver module, power supply module and CC2430. The system chooses CC2430 as the wireless network communication module and makes it as the main hardware platform to realize the design of the system. CC2430 is introduced by Chipcon to realize embedded ZigBee application of chip system. The single chip

integrates analog digital converter, ZigBee radio frequency (RF) front-end, timer, AES128 coprocessor and other peripherals. The CC2430 includes four timer: a general 16 bits (Timer1) and two 8 bits (Timer2, 3) timer, supports the typical timing/counting function, so the CC2430 module can output .PWM dimming signal to the street lamp driver chip directly. The CC2430 module is responsible for information transfer with wireless terminal which installed in other street lamps on the road, and deals with the received data to control LED street lamp switch and realize dimming function. Street lamp node controller can acquisition of voltage, current data in the predetermined time period, then report to the monitoring center. When the field controller detects a street lamp has burst failure then report the fault information to the monitoring center. The LM3409HV as a constant current source drive of LED with wide input voltage range, low adjustable threshold voltage of high-end current detection. The LM3409HV uses constant turn off time (COFF) control to adjust the current without the need for external compensation circuit. It according to the PWM signals allows or prohibits the current through the LED string. The different PWM duty cycle can control

the time that current flowing through the LED string, then realize a dimming function. The typical application of LM3409HV, EN for receiving PWM dimming signal, The COFF through the periphery ROFF and COFF set off, UVLO through RUV1 and RUV2 partial pressure from input under voltage lockout, RSNS used for MOS tube peak current detection, PGATE for driving the peripheral circuit of P – MOSFET[3].

III.USE OF ZIGBEE

For Zigbee-based street light control is a scheme proposed so that we can aim at reducing the human error in the operation of street lights. A lack of automation in the current system leads to large amount of human error in street lighting system. The information is transferred from one point to another by ZigBee transmitters and receivers which are then sent to a control terminal used to check the state of the street lamps and to take appropriate measures in case of failure. The system allows energy savings with increased performance and maintainability. Here we are making an intelligent lamp post which is managed by a remote controlled system that uses LED based lightweight supply and is power is given by renewable energy (solar panel and battery). It is then implemented through a network of sensors to gather the relevant information associated with the management and maintenance of the system. Data is transferred in wireless mode using the ZigBee protocol. The working of whole system has been categorized into following[2][7]:

3.1 LIGHT SENSOR

It will measure the external light intensity and provides assurance to a minimum level of illumination of the road, as needed by regulations. The sensor has high sensitivity which is in the range of the visible spectrum. This provides a photocurrent which is high enough for low-light luminance levels.

3.2 SUPERVISION MODULE

This sensor improves fault management. A Hall sensor detects when the lamp is switched on. The system recognizes errors which are compared with the stored information. This information is reported by the ZigBee network to the station management unit. These devices work along and transfer the information which is collected by them to a Microcontroller that processes the information and chooses the appropriate action.

3.3 CONTROL UNIT

The sensors transfer the collected information to a controller that uses software which is then used to manage the system. If no fault is detected, the microcontroller measures the current by the Hall sensor storing the values in memory. All the operations have predetermined time for management of time. At the stop signal, the lamp is turned off.

3.4 MANAGEMENT SENSOR

The transmission system consists of ZigBee devices that receive data which has information about the state of the lamps and sends it to a terminal. The processing unit consists of a terminal with a serial UART interface that receives data provided by a ZigBee device. The management can be extended so that other electrical systems might send data regarding power consumptions to a central system for adjusting energy consumption to and for remote switching and management.

IV.HARDWARE DESIGN

Street lamp controller is consisted of the voltage/current collection module, LED driver module, power supply module, illumination sensor and CC2430. The system chooses CC2430 as the wireless network communication module and makes it as the main hardware platform to realize the design of the system. CC2430 is introduced by Chipcon to realize embedded ZigBee application of chip system. The single chip integrates analog digital converter, ZigBee radio frequency (RF) front-end, timer, AES128 coprocessor and other peripherals. The CC2430 includes four timer: a general 16 bits (Timer1) and two 8 bits (Timer2, 3) timer, supports the typical timing/counting function, so the CC2430 module can output .PWM dimming signal to the street lamp driver chip directly. The CC2430 module is responsible for information transfer with wireless terminal which installed in other street lamps on the road, and deals with the received data to control LED street lamp switch and realize dimming function. Street lamp node controller can acquisition of voltage, current data in the predetermined time period, then report to the monitoring center. When the field controller detects a street lamp has burst failure then report the fault information to the monitoring center. The LM3409HV as a constant current source drive of LED with wide input voltage range, low adjustable threshold voltage of high-end current detection. The different PWM duty cycle can control the time that current flowing through the LED string, then realize a dimming function. The typical application of LM3409HV, EN for receiving PWM(Pulse Width Modulation) dimming signal, The COFF through the periphery ROFF and COFF set off, UVLO through RUV1 and RUV2 partial pressure from input under voltage lockout, RSNS used for MOS tube peak current detection, PGATE for driving the peripheral circuit of P – MOSFET[4][5][6].

4.1 TRANSFORMER

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. A varying current in one coil of the transformer induces a varying magnetic field, which in turn induces a voltage in a second coil. Power can be transferred between the two coils through the magnetic field, without a metallic connection between the two circuits. Faraday's law of induction discovered in 1831 described this effect. Transformers are used to increase or decrease the alternating voltages in electric power applications.

4.2 RECTIFIER

A rectifier is an electrical device that converts alternating current, which periodically reverses direction, to direct current, which flows in only one direction. The process is known as rectification. Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles

other than to generate direct current for use as a source of power. Many applications of rectifiers, such as power supplies for radio, television and computer equipment, require a *steady* constant DC current (as would be produced by a battery). In these applications the output of the rectifier is smoothed by an electronic filter (usually a capacitor) to produce a steady current.

4.3 REGULATOR

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

4.4 MOSFET DRIVER

MOSFET Driver also called as MOSFET Gate driver is a specialized circuit that is used to drive the gate of power MOSFETs effectively and efficiently in high-speed switching applications. The addition of high MOSFET Gate drivers are the last step of the turn-on is to fully enhance the conducting channel of the MOSFET technology.

4.5 MICROCONTROLLER

A microcontroller (or MCU for *microcontroller unit*) is a small computer on a single integrated circuit. In modern terminology, it is a system on a chip. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

4.6 LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm^2) and integrated optical components may be used to shape the radiation pattern**.**

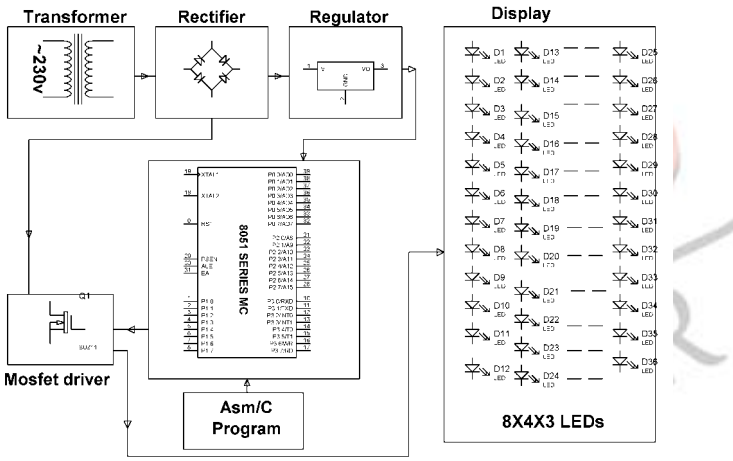

Fig.1Hardware Circuit

V. SCOPE

Energy efficiency is one of the key factors while designing indoor or outdoor lighting systems. The street lights consume almost 30%–40% of the entire city power consumption. For this aim, because of its design based on the old lighting standards and inefficient instruments and devices, the traditional lighting systems are not suitable resulting in energy losses. Main aim is to automate street power saving system to save the power. We want to save the power automatically instead of doing it manually. So, it's easy to make it cost efficient. This saved power can be used in some other cases. Hence, in villages, towns, etc. we can design intelligent systems for the usage of street lights. This concept in future can be enhanced by integrating it with the solar panel, which converts the solar intensity into corresponding voltage, and this energy can be used to feed the highway

VI. CONCLUSION

This intelligent street lighting system described, it integrates new technologies, offering ease of maintenance and energy savings. This is obtained by using the highly economical LED technology supplied by renewable energy provided by the solar panels and by using the intelligent management of the lampposts. The proposed system is especially appropriate for street lighting in remote urban and rural areas where the traffic is low at times. Independence of the power network permits to implement it in remote areas where the classical systems are prohibitively expensive. The system is versatile, extendable and totally adjustable to user needs.

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