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A Survey Paper on Street Light Controlling for Energy Efficiency

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ABSTRACT

Energy efficiency is the key factor in electronic devices. The more the device is energy efficient lesser the wastage of energy and lesser the cost of the electricity. The energy used by street light system is used after sunset to sunrise but the amount of energy consumed is far higher. However if the energy consumed by the street light is controlled then it will be useful as the saved energy can be utilized for other fruitful purpose. This paper provides quick overview of various street light controlling techniques and communication techniques proposed recently.

Keywords

Energy Efficiency, Street Light Control, light intensity control

1. INTRODUCTION

With the continuous improvement of country urbanization level and the rapid development of economy, the urbanlighting system is expanding. How to save energy and improve the management level of the street light system has attracted more and more people's attention. Currently, given the security, most of the city street lights use the pattern of"full night-lights, constant illumination lighting", which not only causes more energy waste, but also loss of the lamp life,seriously affecting the used time of the lamp and causing waste of lamps and lanterns.

The main focus of street light control system is to minimize the operations and maintenance costs and upgrading the existing lighting with innovative energy efficient fixtures. The systems have central remote control which makes the use of a dedicated system that has software installed that maintains a database of each node.

2. SYSTEMS PROPOSED FOR STREET LIGHT CONTROL

Various techniques to control the street light are mentioned below. The advantage of each proposed system will be analyzed.

2.1. Street Light Control through ZigBee and LED dimming technique

ZigBee is the rising wireless network technology with short distance and low rate. It is a sort of technology project between wireless marker technology and Bluetooth, mainly for the near distance wireless connections.

PWM dimming is used for LED intensity and energy consumption reduction because it won't produce chromatography migration, has higher dimming precision, and can combine digital control technology. Flicker phenomenon won't happen even if there is a wide range adjustment light.

2.1.1 System Design:

The system consisted of the monitoring center, wireless network and the street lamp terminal installed onthe street lamp pole, and the system structure is shown in Figure 1. Street lamp nodes and the monitoring center needto be equipped with wireless communication module.

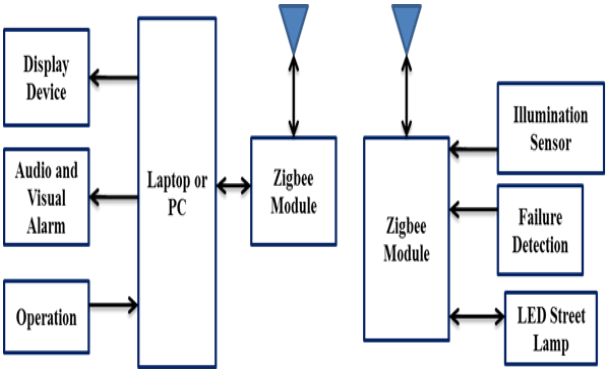

Figure 1: Block Diagram

Street lamp energy-saving system is realized by three network layers, as is shown in Figure 2. The

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monitoringlayer mainly accomplishes system monitor screen and the interaction design of control instruction by PC machine. Themiddle layer made up of subnet coordinator transfers the data message to PC through the GPRS communicationtechnology. Routing node installed in a street lamp poles, plays a role in relaying between the street lamp and otherwireless nodes. CC2430 chip used for the system contains a high performance 2.4GHZ DSSS RF transceiver core and atechnical grade small efficient 8051 controller, it can be directly used as the system controller in the hardware.ZigBee network coordinator is responsible for establishing network and management network, forming aZigBee subsite. Remote control center forms large area control network by connecting each ZigBee subnet withGPRS network.

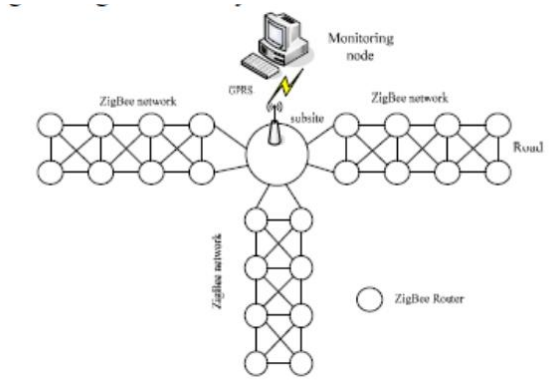

Figure 2: Network based on Zigbee

2.1.2 Street Lamp Node:

Street lamp controller is mainly consisted of the voltage/current collection module, illumination sensor, LEDdriver module, power supply module and CC2430. The structure is shown as Figure 3

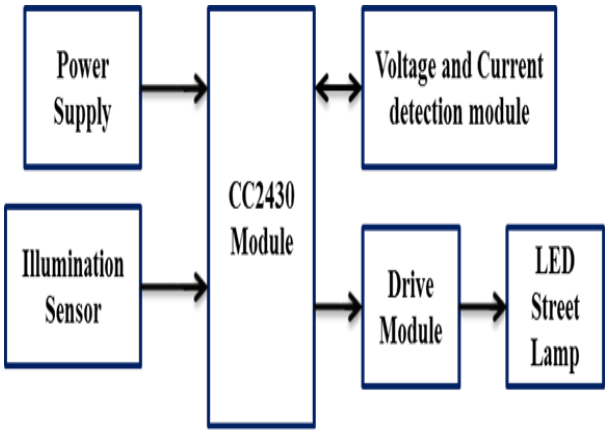

Figure 3: Block Diagram of Street Lamp Node

2.1.3 Advantages/Disadvantages

- Advantages: Serviceability of street light is available
- Disadvantages: Data of group of street light system is gathered and then sent to the service station. If this is not functioning then whole communication system breaks. The hopping of message from one to other node has done to pass the message, so if any node in system fails then the trailing nodes data will be lost/unavailable.

2.1.4 Flowchart of the System

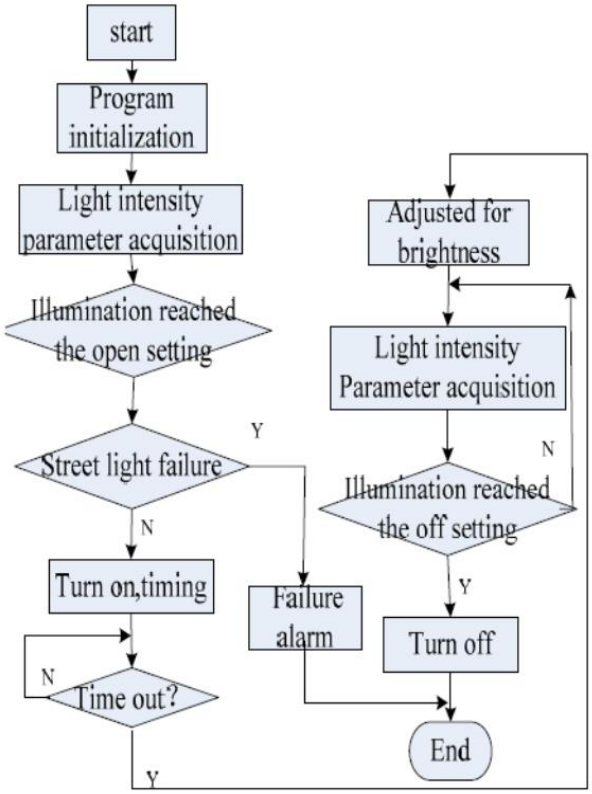

Figure 4: Flowchart of the Proposed System

2.2 Street Light Control using RTC and Temperature Sensor

2.2.1 System Design

Most of the current high power light emitting diode (LED) street lighting systems are designed for illumination without any intelligent control and cannot adjust the illumination status efficiently. A few of the LED street lighting systems have intelligent control; however, they can neither automatically detect the illumination status of the systems nor adjust the systems manually. Wired

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cable controls are adopted in most current illumination management systems to adjust the illumination status of the LED street lamps, but with disadvantages of complicated communication protocols, high construction cost and high operation cost. Proposed low cost real-time intelligent control system overcomes the drawbacks of the current LED lighting systems mentioned above. It is based on a Microchip PIC16F877A Micro Controller Unit (MCU), combined with a temperature module based on DS18B20 and a clock module based on DS1302, and programmed to output Pulse Width Modulation (PWM) to control the output current.

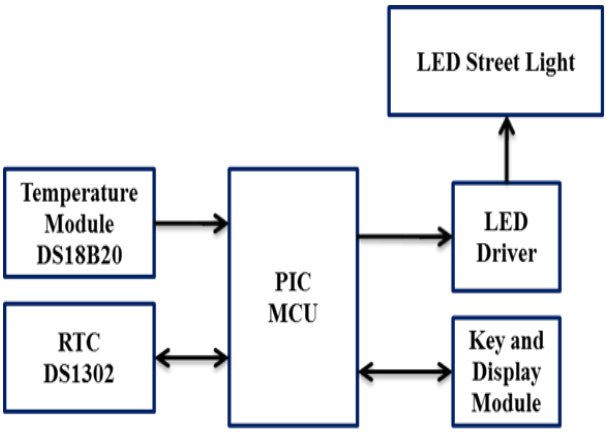

Figure 5: Block Diagram of Street Light Control using RTC and Temperature Sensor

The temperature module monitors the substrate temperature of the LED street lamps. When the temperature is too high, the certain measures are carried to increase the life of the lamps. The temperature sensor is DS18B20 produced by the DALLAS company, having miniaturization, low power consumption, high-performance, strong anti-jamming capability, and is easy to match processor. The communication between the MCU and DS18B20 only needs a data line. It can directly convert the temperature value into serial digital signals to process. The circuit is simple and low-cost. For high-power LED lights, the temperature control is very important. The high or lowtemperature affects the LED luminous efficiency and the lifetime. When the temperature is too high, we canadjust the output current by the PWM duty cycle to ensure the LED works well.The intensity of the street light is controlled with the help of the data received from the RTC. The RTC provides date, time related information so with hard coded program it checks the received time and compares it with the stored data. Based on the comparison the street light intensity is controlled. The decision of light intensity is taken on the pre-stored algorithm. The light intensity is decreased during night time and at day time PWM signal has low so LED driver output is zero so the lamp will be in off state.

2.2.2 Advantages/Disadvantages:

- Advantages: Simple and cost effective LED temperature dependent current drawn from LED which will increase the life of LEDs
- Disadvantages: Serviceability of the system is poor as it purely based on human intervention based. If RTC is misbehaving then whole system collapses

2.3 Street light controlling with user defined time and Vehicles Movement

The proposed system consist of the control unit, communication interface and sensors for time duration. For example in the evening from 20:00PM to 22:00PM the light intensity time day and time related information. The user can set light intensity as per required in time duration. For example in the evening from 20:00PM to 22:00PM the light intensity required is 95% and after 22:00PM the intensity required is 45% and after 01.00AM onwards the intensity required is 30% like this the data can be set in the program or can be varied as per user settings.detecting vehicle and light of. The Block diagram of system is mentioned below.The system consists of the JN5148 wireless transceiver, the dimming circuit that uses a PWM (Pulse Width Modulation) signal, the vehicle detection circuit and the circuit for detecting potential malfunctions.The proposed system controls the street light

The street lighting control system must be able to detect any malfunctions that may occur due to any lamp that does not work within normal parameters, without any need for on-site inspection or passer-by notifications. These malfunctions are reported to the command center.The ACS714 current sensor made by Allegro used for detecting fault in the node. If the lamp is not working then the sensor provides data output corresponding to dark light.

The light intensity is also adjusted according to the vehicles passing from that road.For this purpose the PIR sensor or Doppler sensor can be used.Due to some disadvantages of PIR sensor, Doppler sensor has used.

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Limitations of PIR sensor

1. Sensitivity to sudden temperaturechanges in the environment.
2. Activation time 60sec (± 5sec)
3. Sensitivity to direct sunlight exposure.
4. Detection range 15 m
5. Detection time 2 sec (± 0.5sec)
6. False alarms

Functionality of PIR sensor gets affected due to environmental conditions so because of this reason false signal may get. Therefore to avoid this Doppler sensor can be used to detect vehicle movement.

2.3.1 Doppler sensor:

Another way to achieve vehicle detection is the integration of a sensor that uses the Doppler Effect. The sensor sends an electromagnetic (EM) signal to an object and receives back a signal reflected from that particular object. By monitoring the delay between the signal transmission and the reception of the reflected signal, the distance to the object can be determined. If the object is moving, the frequency of the received signal will be translated from the frequency of the sent signal to another frequency, and this effect is known as the Doppler Effect. The translation of the Doppler frequency is determined by the radial velocity of a moving object in the LoS (Line of Sight) direction. The sensor can measure the radial velocity of a moving object, based on the changing Doppler frequency of the received signal. The Doppler frequency shift is usually measured in the frequency area by means of the Fourier transformation of the received signal. In the Fourier spectrum, the maximum component is the Doppler frequency induced by the radial velocity of the direction of movement of the object. The Doppler frequency bandwidth is an estimate of the movement velocity through the micro-Doppler effect. The frequency of the transmitted signal should be as stable as possible in order to achieve the proper monitoring of the received signal status. [1]

The features of proposed system:

1. Street Light malfunction indication to control station with help of the communication interface
2. Street Light intensity control can be done according to vehicle density
3. Intensity control by employing PWM control

3. SUMMARY

All the proposed system are having some advantages and limitations. The energy can be saved by employing PWM dimming according to the geological conditions. The RTC has been used which provides time and date related information. Based on RTC data the controller increase or decrease the intensity of lamp. The LEDs are efficient as compared to conventional HID and Incandescent lamps.The LEDs have long working span as compared to conventional lamps but it performance depends on the temperature of the LEDs.If the current flowing through LEDs adjusted over the period of the time according to the LED dial temperature then the intensity of LED can be stable over the period. The street light some time malfunctions, this information needs to be communicated to control station. Communication media like ZigBee,GSM module can be used to send the data over the long distance.

The advantages of all the systems can be grouped together to form energy efficient as well as easy to implement.The system which combines all the advantages of various system may contains following architecture:

The system can be divided into 3 Sections

- Master Node in number of street light Poles
- Street Light Pole as Node
- Control Station

1. **System at the Pole**:

- Equipped with PWM Dimming capability
- Light sensing Sensor
- Temperature Sensor for Lamp
- Vehicle detection Module
- Communication interface which can communicate with Master Node (ZigBee based)

2. **System at the Master Pole**:

- Equipped with PWM Dimming capability
- Light sensing Sensor
- Temperature Sensor for Lamp
- Vehicle detection Module
- Communication interface which can communicate with Slave
- Node (ZigBee based) and GSM module for communicating with Control station

3. **Control Station:**

- GSM Module interfaced to PC
- GUI for operating Street Light System for large geographic area

4. CONCLUSION

Adopting this proposed Street Light Control system can reduce energy consumption by around 50%.The energy consumption reduction is the way to energy creation. Thus the proposed system mentioned provides intelligent way for street light intensity control with serviceability function which provides lesser time to service the faulty Street light pole as well as it provides smart system that enhances the aesthetical view of city.

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