Distributed Intelligent Street Lamp Monitoring and Control System Based on Zigbee

R. Kavitha[1], **N. Thiyagarajan**[2]

PG Student, M.E (Embedded Systems),

Assistant Professor ECE, AMS Engineering College, Namakkal

Abstract: ***Autonomous devices embedded along with sensors which monitor the environmental parameters using the various sensor and an emergency switch.ZigBee-based wireless devices which allow more efficient street lamp system management. The information is transferred point-by-point using Zigbee transmitters and receivers and is 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 substantial energy savings with increased performance and maintainability. More power consumption, saving money through solar panel, saving precious time, decrease the huge human power through from the IR Sensors. The Street lights are controlled through a specially designed Graphical User Interface (GUI) in the PC. The Zigbee technology can be used for the street lights monitoring and controlling at the PC end.***

Keywords: Automation, control system, lighting system, sensors, wireless networks, Zigbee.

1. Introduction

Due to the increase of environmental concerns, lighting control systems will play an important role in the reduction of energy consumption of the lighting without impeding comfort goals. Energy related emissions are responsible for approximately 80% of air emissions and central to the most serious global environmental impacts and hazards, including climate change, acid deposition, smog and particulates. Lighting is often the largest electrical load in offices, but the cost of lighting energy consumption remains low when compared to the personnel costs. Thus its energy saving potential is often neglected. The share of electricity for lighting is around 20-30% in hospitals, 15% in factories, 10-15% in schools and 10% in residential buildings. Intelligent lighting control and energy management system is a perfect solution for energy saving, especially in public lighting management. It realizes remote on/off and dimming of lights, which can save energy by 40%, save lights maintenance costs by 50%, and prolong lamp life by 25%. The system compromises of server, GUI to display and nodes which are micro controlled processed with embedded sensors measuring different parameters. This scenario increases life of streetlights, reduces power consumption, ease of monitoring and controlling.

1.1 Remote Street Light Control Terminal

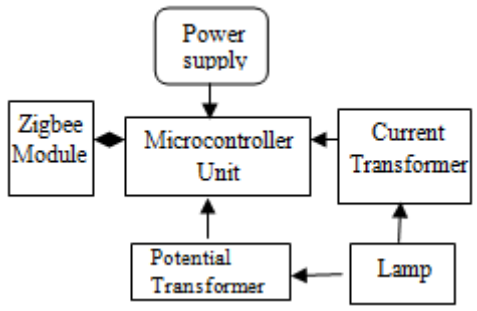

Figure 1: Remote street light control terminal

In this unit is used to control the single street light. We use current transformer and potential transformer for measuring current and voltage of the individual lamp. By using the two parameters we can detect which type of fault occurred in the terminal unit. If the voltage value is equal to zero, then there is possible situation for line fault. If the current value is equal to zero, then the load have problem.

The network is built to transfer information from the lamp posts to the base station control. Information is transferred point by point, from one lamp post to another where each lamp post has a unique address in the system. The operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The lamp module varies according to the intensity levels e.g.; when at peak hours bright lights are needed and at midnight dimming light levels are required. These changes take place based on the requirements needed.

2. General Concept of the System

The solar panel is used for generating power and it will be stored into the rechargeable battery from that to power supply and then to the street lights using relays. Here two modes of operations: AUTO & MANUAL operations.

2.1 Auto Mode

In this automatic mode operation we are using LDR Sensor (Light Dependent Resistor) for measuring light intensity for switched ON or OFF the street light using relays. The main principle of LDR is when the light intensity is low; light is going to be ON otherwise it's going to be OFF. For the efficient reduction of power wastage IR (Infrared) Sensor is integrated. If any vehicle or obstacle is detected using IR sensor at that time it will check the light intensity level using LDR sensor then light will go ON or OFF.

2.2 Manual Mode

In this manual mode, the street lights are controlled through a specially designed Graphical User Interface (GUI) in the PC. The Zigbee technology can be used for the street lights monitoring and controlling at the PC end. The system consists of a group of measuring stations in the street. (One station located in each lamp post) and a base station located nearby. The system is designed as a modular system, easily extendable. The LDR Sensors are used to observe street conditions as the light intensity of daylight and, depending on the conditions they activate or off the lamps.

3. System Block Diagram

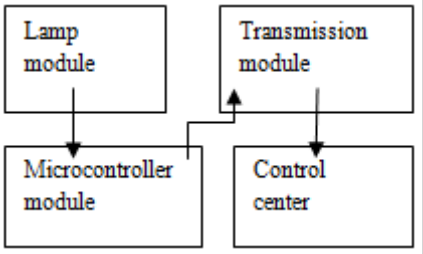

Figure 2: Block Diagram of the Smart

4. Street Lamp Monitoring System

Here the complete smart street lamp monitoring system, where inside the lamp module, it consists of light dependent resistors (LDR) module, microcontroller module and transmission module. The lamp module will communicate with the control centre through wireless using Zigbee. In the LDR module, it consists of two LDR. One of the LDR is install on top of the street lamp for the checking the day/night status condition. Another LDR is place under the street lamp to monitor and checking the lamp health status. The results of the LDRs send to microcontroller, where the microcontroller will process the data and send the data to the transmission module. In the transmission module, there is wireless Zigbee that transmit the data through wireless to the control centre. In the control centre, it will monitor each of the street lamp status, as well as controlling the operation of the street lamps. All the four modules put together to form an efficient intelligent street lamp monitoring. An alarm or buzzer is kept at the control room to monitor the failure or emergency condition all of the sudden.

4.1 Monitoring Stations

The monitoring station located in each lamp post consists of several modules: the rain sensor, the air velocity sensor, and an emergency switch. These devices work together and transfer all of the information to a microcontroller which processes the data and automatically sets the appropriate course of action. A priority in the transmission of information is assigned to each sensor, for example, the emergency switch takes precedence over any other device.

4.2 Rain Detection Sensor

The amount of rainfall is measured using a rain gauge. It is expressed as the depth of water that collects on a flat surface, and is routinely measured with accuracy up to 0.1 mm or 0.01 in. The circuit is designed with two lines that are tracked with very short distance. When rain drops falls on this circuit, the track may become short circuit. It gives the corresponding signal to related circuit in order to find the rain fall.

4.3 Air Velocity Sensor

Operation of the sensor depends upon the adsorption of water vapor into a porous non-conducting "sandwich" between two conductive layers built on top of a base ceramic substrate. The active sensor layer and the porous top conductor, that allows transmission of water vapor into the sensor, are engineered very thinly. Therefore the sensor responds very rapidly to changes in applied moisture, both when being dried (on process start-up) and when called into action if there is moisture ingress into a process.

4.4 Buzzer

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. The AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker.

4.5 IR Sensing Circuit

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator. When IR transmitter passes the rays to receiver, the IR receiver is conducting due to that non inverting input voltage is lower than inverting input. The inverter output is given to microcontroller

4.6 Zigbee Network

Zigbee is a wireless communication technology based on the IEEE802.15.4 standard for communication among multiple devices in a wireless personal-area network (WPAN).The typical distance of a Zigbee transmission range, depending on the environment conditions and the transmission power, shifts from tens to hundreds of meters, and the transmission power is deliberately kept as low as possible to maintain the lowest energy consumption. The network is built to transfer information from the lamp posts to the base station control. Information is transferred point by point, from one lamppost to another where each lamp post has a unique address in the system. Each lamp post can only send the information to the

nearest one, until the information reaches the base station PC.

Figure 4: Test system

This circuit is mainly used to for counting application, intruder detector etc. The comparator is constructed with LM 741 operational amplifier. In the comparator circuit the reference voltage is given to inverting input terminal. The non inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting.

Finally, Fig. 4.1 shows the operational test system working in real conditions. It is visible that the proposed systems can also be used for upgrading existing conventional lamp posts. Power is supplied by a battery recharged by a solar panel during the daytime. The capacity of the battery depends on the specific needs of the final application. The charge controller manages the processes of the battery charge and power supply.

5. Remote Centralized Control System

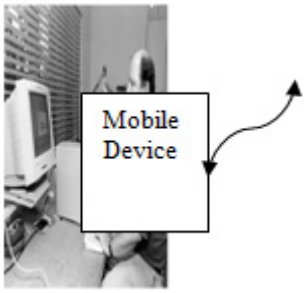

Figure 5: Remote control system

The unit has ability to monitor and control the street lights in more than one area. The unit also sends information to Remote centralized control system about which area lights are working and not working through Zigbee network. This unit major function is monitoring more number of Remote Concentrator. It also used to turn on the street lights regularly**.**

Technologies Used

The technology that used can control the street lights automatically on and off through LDR sensor and RF technology and we can send the status of the street lights to mobile in control room using Zigbee module. Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter.

6. Software Tools

6.1 MPLAB

MPLAB SIM is a discrete-event simulator for the PIC microcontroller (MCU) families. It is integrated into MPLAB IDE integrated development environment. The MPLAB SIM debugging tool is designed to model operation of Microchip Technology's PIC microcontrollers to assist users in debugging software for these devices.

6.2 VISUAL BASIC

Visual Basic is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming. VB program can interact with user using graphical elements like windows, buttons, tool bars. Graphical user interface (GUI) is a visual way of interacting with computer such as icons, menus. It is a user interface used to interact with electronic devices through graphical icons.

7. Conclusion

This paper describes a new intelligent street lighting system which integrates new technologies available on the market to offer higher efficiency and considerable savings. The control system is the intelligent management of the lamp posts by sending data to a central station by Zigbee wireless communication. The system maintenance can be easily and efficiently planned from the central station, allowing additional savings.

Furthermore efficient power management street lights can be obtained by using wireless power transmission which would further reduce the maintenance costs and power thefts of the system, and also avoid cable breaking of the system. In addition to this, controlling the Traffic Signal lights would be another feature. Depending on the amount of traffic in a particular direction, necessary controlling actions could be taken. Also emergency vehicles and VIP convoys can be passed efficiently. Moreover, attempts can be made to ensure that the complete system is self-sufficient on nonconventional energy resources like solar power, windmills, Piezo-electric crystals, etc. these advancements can make this system completely robust and totally reliable in all respects.

References

[1] M.A.D. Costa, G. H. Costa, A. S. dos Santos, L. Schuch, and J. R.Pinheiro, “A high efficiency autonomous street lighting system based on solar energy and LEDs,” in Proc. Power Electron. Conf., Brazil,Oct. 1, 2009, pp. 265–273.

[2] P.-Y. Chen, Y.-H. Liu, Y.-T. Yau, and H.-C. Lee, “Development of an energy efficient street light driving system,” in Proc. IEEE Int. Conf.Sustain. Energy Technol., Nov. 24–27, 2008, pp. 761–764.

[3] Chaitanya Amin, AshutoshNerkar, Paridhi Holani, Rahul Kaul,“GSM Based Autonomous Street illumination System for Efficient Power Management“(Int.Journal of Engg.Trends and Tech- Vol 4 Issue1- Aug-2013)

[4] Huang-Jen Chiu, Yu-Kang Lo, & Shih-Jen Cheng," Design and Implementation of a Photovoltaic High-Intensity-Discharge Street Lighting System, IEEE trans. On power elect, vol.26, no.12, Dec 2011.
[5] Stefancel Mare Univ, Suceava, Romania, Valentin, P, "Hardware design of a street lighting control system with vehicle and malfunction detection, IEEE trans on Advanced Topics in Electrical Engineering (ATEE),23-25 May 2013.
[6] W. Yue, S. Changhong, Z. Xianghong, and Y. Wei, "Design of new intelligent street light control system," in Proc. 8th IEEE Int. Conf.Control Autom., Jun. 9– 11, 2010, pp. 1423–1427.
[7] Xingming Long, Jing Zhou, "An Intelligent Driver For Light Emitting Diode Street Lighting," in IEEE Auto. Con.WAC Sept. 28/2008-Oct. 2/2008.
[8] Manuel Arias, Diego G. Lamar, Javier Sebastian, Didier Balocco,and Almadidi Aguissa Diallo," High-Efficiency LED Driver Without Electrolytic Capacitor for Street Lighting"IEEE Tran. on ind. appli. vol. 49, no. 1, JAN/FEB 2013
[9] D.Liu, S.Qi, T. Liu, S.-Z. Yu, and F. Sun, "The design and realization of communication technology for street lamps control system," in Proc.4th Int. Conf. Computer. Sci. Educ., Jul. 25–28, 2009, pp. 259–262.

Author Profile

Mr. N. Thiyagarajan is Assistant Professor in (Electronics and Communication Engg) Annai Mathammal Sheela Engineering College, Namakkal, Tamilnadu, India

Mrs. R. Kavitha is student of second year M.E. (Embedded Systems) Annai Mathammal Sheela Engineering College, Namakkal, Tamilnadu, India