ISSN: 2249-7196
IJMRR/July 2022/ Volume 12/Issue 3/ 01-6
Dr.M.S.Priyadarshini /InternationalJournalofManagementResearch&Review

Monitoring and Management of Street Lighting System using Internet of Things

Dr.M.S.Priyadarshini
Associate Professor, Department of Electrical and Electronics Engineering
K.S.R.M College of Engineering (Autonomous)
Kadapa, India
priyadarshini@ksrmce.ac.in

Abstract

Different forms of utilization of electrical energy include lighting system. General lighting system provided by utilities must be ensured that there is no wastage of power during consumption. Street lighting is of importance keeping in view of prevention of accidents and adequate lighting must ensure safety and comfortable driving. In this paper, Internet of Things (IoT) is used to monitor and manage street lighting system. IoT based nodes and sensors are arranged in such a manner that wastage of power consumption is avoided. Transformers, relays light dependent Resistor (LDR) sensor and passive infrared (PIR) sensors are the major equipment in the setup. Raspberry Pi and Arduino serve as nodes through wireless serial port communication HC-12 module. Instrument transformers are used for voltage and current measurement. Monitoring can be done if the respective power consumption values are uploaded to server. In this paper, it is shown that this model results in effective monitoring and management of street lighting system using IoT.

Keywords— Arduino, Internet of Things,Nodes, Sensors, Raspberry Pi, HC-12 module

1. Introduction

Lighting is one of the major applications falling under the category of utilization of electrical energy. Domestic, commercial, street, factory and flood lighting are few of different categories. For road safety requirements, the main responsibility of governing authorities is to provide proper street lighting. Lighting can account for considerable percentage of the total energy consumption. Street

lighting is very important keeping in view of socio-economic conditions and for strategic development of economy. Poor lighting results in unsafe conditions and wastage of expenditure. Technologies that result in energy efficient methods can reduce street lighting costs. These savings on a larger extent can result in elimination of wastage and reduce the necessity for installation of new generating plants to meet additional power requirements.

2. Literature Review

To enhance street lighting monitoring and for effective observation and control, the concept of Internet of Things (IoT) is used. The main parts of smart street lighting system are controller for controlling the light and other integrated sensors, server and lighting fixtures [1]. Various topologies have been used for dimming the light like single stage, double stage and circuits like constant current feedback, constant voltage feedback [2]. In 2017, Cacciatore and his team has suggested that when there are no people on roads, we can reduce the brightness by using some techniques which will give good results in saving power [3].

Monitoring and controlling of street lights can be done by connecting relay board and other required components to Raspberry Pi gave a good performance [4]. An important application has been described for mobile crowd sensing and to detect the activity and for geo-fencing an open-source solution has been presented which is known as Mobile Sensing Technology [5]. LEDs are the good solutions for power reduction and there are some dimmer based TRAIC based street lighting systems which are discussed in [6]. The authors have analyzed that LEDs are better to use as street lamps after comparing the HPNa and LED lamps [7-8]. Mohsen and Farzad have proposed the system which has segment, pole controllers also power line communications were used. Scheduling, switching actions and dimming level of lights had determined by segment controller. In-case, if there is any fault then segment controller gets that information [9-10]. Smart cities require IoT technology. Technical opportunities and challenges have been reviewed and explained clearly in [11].

Monitoring and controlling can be done effectively if the measured values are transmitted properly by using any transmission module. HC-12 module has used as a transceiver and solar panel, battery, few sensors were also used and with this system the authors have proved that only thirty percent of power can be reduced [12]. Two centralized dimmers have been compared by using two different technologies Multiple-Tapped Autotransformer and High-Frequency Switching Converters namely and these are discussed in [13-14]. Gul Shahzad and his team have developed a street lighting system

using traffic adaptive control. Smart grid architecture had been developed and implemented in a campus and results have shown that more than 60% of energy has been saved[15].

Street lighting is made smart and adaptive based on climate changes and by using sensors [16-18]. If the light is dimmed in the absence of traffic and humans then it saves energy. Also, if we dim the light based on schedule it saves more energy. The main objective of this proposed work is making the light to glow with high, medium and low intensities using relays with low cost. When depending on the traffic and humans on avenues, we reduce the light intensity. Thereby the energy consumption can be reduced and can be monitored and controlled from remote location.

3. Proposed system

The proposed system consists of two nodes slave node and master node respectively. Master node controls the slave node. The obtained values are uploaded to the Internet from the master node. Radio frequency module is used for master and slave node performs communications in the proposed system. In the proposed system, the supply voltage to the lamp can be reduced in order to reduce the intensity of light. Arduino is used as a slave node. It consists of transformer with two tappings, relay board, current transformer and signal conditioning board, potential transformer and lamp holder. Light dependent resistor and Passive Infrared sensor are also connected to the Arduino in order to provide a smart street lighting system. Relays play a major role in making the light to glow with different intensities. Relays operation can be controlled by the Arduino micro controller.

The proposed system is designed in such a way that as per scheduled timings with different required intensities the system can work and it can be controlled by concerned authorities through internet. Signal conditioning board gets values from potential and current transformers and those are converted to DC values by this board. Those values can be sent to Arduino. It has HC-12 RF module and this module transmits the data to the master node.

In the proposed model Raspberry Pi acts as master node and slave node is under the control of Master node. It contains inbuilt real time clock. It checks the timings which are mentioned in program and according to them it passes commands to slave nodes. All the measured current values can be transmitted to master by the slave. Those are uploaded to cloud via Internet. Hence the proposed system can reduce power consumption and ultimately it is useful in saving energy.

When light falls on LDR sensor, resistance goes to low level may be less than 1kilo ohm. Passive Infrared (PIR) sensor also known as Piezoelectric and Infrared motion sensor is used for motion

detection. HC-12 is a radio frequency module which is used for long distance communication approximately 1 kilometer with 433.4 to 473.0 MHz frequency range. The voltage range that can be applied as input is 3.2V to 5.5V DC.

4. Hardware Setup

Master node has both Arduino and Raspberry Pi. Arduino in master node will transmit and receive the commands and values. Raspberry Pi is used to upload data to cloud. When the Arduino passes commands as per scheduled timings and by the user through internet, the light can glow with different intensities. The hardware setup arrangement Is depicted in fig.1.

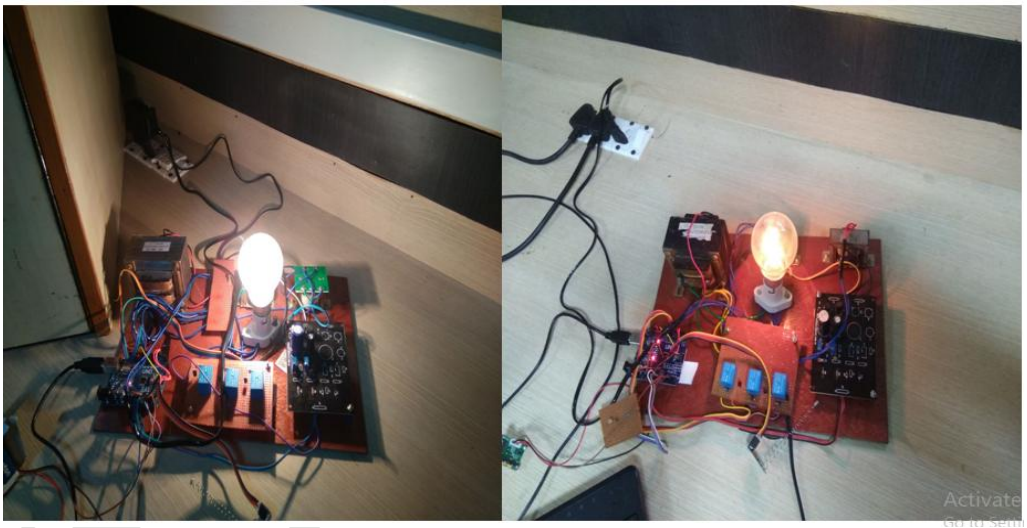

Fig.1. Hardware setup with variation in intensity of brightness

If there is no update in values then an alert message is obtained to the registered mobile number that the node has failed. The measured values of voltage, current and energy consumption are displayed on output screen. The values which are updated to the server can be monitored in Thingspeak website. After having an application programming interface (API) key and channel ID. From this user can monitor the updated values from time to time. If the user copies that link address then user can control the lighting system by using internet from anywhere.

5. Conclusion

IoT based smart street lighting system prototype model has been designed and implemented. Intensity of light can be reduced by using relays. The system has control by both as per scheduled

timings as well as by the user through internet. The power consumption and energy consumption will be reduced by the proposed system. The output results have been uploaded to the server. According to those results it is proved that this street lighting system based on IoT is effective and can be monitored with effective management. It's implementation in real time will be resulting in saving in economy and reducing wastage of power consumption. This leads to economical utilization of electrical energy.

References

[1] Barve, V. (2017). "Smart lighting for smart cities." 2017 IEEE Region 10 Symposium (TENSYMP), 1–5 (July).

[2] C. Jane, G., Su, C.-C., Chiu, H.-J., and Lo, Y.-K. (2012). "High-efficiency led driver for street light applications." 2012 International Conference on Renewable Energy Research and Applications (ICRERA), 1–5 (Nov).

[3] Cacciatore, G., Fiandrino, C., Kliazovich, D., Granelli, F., and Bouvry, P. (2017). "Cost analysis of smart lighting solutions for smart cities." 2017 IEEE International Conference on Communications (ICC), 1–6 (May).

[4] Calugay, A. A. P., Santos, G. D. R., Santos, J. I. S., Tolentino, R. T., and Zhuo, E. R. (2016). "Web-based power board using raspberry pi." 2016 International Conference on Integrated Circuits and Microsystems (ICICM), 50–54 (Nov).

[5] G. Cardone, A. Cirri, A. Corradi, L. Foschini, R. Ianniello, and R. Montanari, "Crowdsensing in urban areas for city-scale mass gathering management: Geofencing and activity recognition," IEEE Sensors Journal, vol. 14, no. 12, pp. 4185–4195, Dec 2014.

[6] Ahmed Farahat, Anna Florea, , Jose Luis Martinez Lastra, Christian, and Francisco Javier Azcondo Sánchez, "Energy Efficiency Considerations for LED-Based Lighting of Multipurpose Outdoor Environments" IEEE Journal of Emerging and Selected Topics in Power Electronics, Vol. 3, No. 3, September 2015

[7] Hanaa Karawia , Mohamed Elhoseiny, Maha Mahmoud, "Harmonic analysis for street lighting lamps", IET Journals & Magazines, Vol. 2017, Iss. 1, pp. 655–658.

[8] Ching-Cherng Sun, Xuan-Hao Lee Ivan Moreno Chen-Hao Lee Yeh-Wei Yu Tsung-Hsun Yang Te-Yuan Chung, "Design of LED Street Lighting Adapted for Free-Form Roads" IEEE Photonics Journal, Volume 9, Number 1, February 2017

[9] Mahoor, M., Salmasi, F. R., and Najafabadi, T. A. (2017). "A hierarchical smart street lighting system with brute-force energy optimization." IEEE Sensors Journal, 17(9), 2871–2879.

[10] Zeeshan Kaleem, Tae Min Yoon, and Chankil Lee, "Energy Efficient Outdoor Light Monitoring and Control Architecture Using Embedded System", IEEE Journals & Magazines of IEEE Embedded Systems Letters, Volume: 8, Issue: 1. 2016.

[11] Daniel Minoli, Kazem Sohraby, and Benedict Occhiogrosso, "IoT Considerations, Requirements, and Architectures for Smart Buildings—Energy Optimization and Next-Generation Building Management Systems", IEEE Internet of Things Journal, Vol. 4, No. 1, February 2017.

[12] Sarkar, S., Mohan, K., and Vankhande, P. (2017). "Smart street-lighting using green energy designing a novel stand-alone solar powered lighting system." 2017 International Conference on Intelligent Computing and Control Systems (ICICCS), 157–163 (June).

[13] Guillermo Velasco-Quesada, Manuel Román-Lumbreras, and Alfonso Conesa-Roca, "Comparison of Central Dimmer Systems Based on Multiple-Tapped Autotransformer and High-Frequency Switching Converter" IEEE Journals & Magazines IEEE Transactions on Industrial Electronics, Vol. 59, No. 4, April 2012

[14] Shere, V. and Suryawanshi, R. (2016). "A review on triac controlled energy efficient dimmable led driver for street lighting." 2016 International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT), 239–241 (Sept).

[15] Gul Shahzad, Heekwon Yang, Arbab Waheed Ahmad, and Chankil Lee, "Energy-Efficient Intelligent Street Lighting System Using Traffic-Adaptive Control" IEEE Sensors Journal, Vol. 16, No. 13, July 1, 2016

[16] Yu-En Wu, "Design and Implementation of an LED Automatic Lighting System for Plant Factories", *IEEE Photonics Journal*, vol.13, no.4, pp.1-9, 2021.

[17] Willy Stephen Tounsi Fokui, Michael Saulo, Livingstone Ngoo, "Climate Change Mitigation in Cities by Adopting Solar Streetlights with Energy Management Capabilities: Case of Nairobi", *2022 IEEE 21st Mediterranean Electrotechnical Conference (MELECON),* pp.390-395, 2022.

[18] R. Porins, P. Apse-Apsitis and A. Avotins, "PIR-Sensor Based Street Lighting System Control", *2020 IEEE 8th Work. Adv. Information Electron. Electr. Eng. AIEEE 2020 - Proc.*, pp. 21-24, 2021.