IOT based Smart Surveillance and Control of Street Light System

Pazhanimuthu C[1], Pandia Raja Prabhu T[2], Praveen Guru M[3], Suresh S[4]

Assistant Professor, Department of Electrical and Electronics Engineering,
KPR Institute of Engineering and Technology, Coimbatore, Tamil Nadu, India.[1]

UG Scholar, Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamil Nadu, India.[2]

UG Scholar, Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamil Nadu, India.[3]

{cpazhanimuthu@kpriet.ac.in[1], 18ee052@kpriet.ac.in[2], 18ee056@kpriet.ac.in[3]}

Abstract. The pace of urbanization has increased significantly over the past few decades. Urban areas need improved services and applications to enable better lifestyles. The implementation of the Internet of Things could significantly improve the urban lighting system, as it consumes more energy than the rest of the city. Lighting fixtures consume a lot of energy, so improving efficiency and detecting failures quickly is a major challenge. The conventional street light control systems require maintenance and manual work. The proposed IoT-based street light control system uses the web-based controls as an energy-efficient alternative. The system uses wireless technology to connect all streetlights to a common Wi-Fi network, solving the problem of unorganized and unsystematic maintenance. The developed prototype system works well for controlling each street lighting system individually and reduces the power consumption through an LDR sensor, which controls the LED brightness. It monitors the status and turns off electrical equipment from a central location, which results in improved system efficiency and centralized device management significantly reduces the power consumption.

Keywords: Internet of Things, IoT, Fault detection, Smart surveillance, Street light control.

1Introduction

The Internet of Things (IoT) is a system connected with sensors, computers, and modern devices spread all over the world through the internet that communicates with each other and gives each device a unique ID assigned as a UID (unique identifier). They use it to exchange and transfer information [1], [2], [3]. With the growth of various commercial facilities and businesses, the focus on automation of these facilities has increased dramatically [4]. As city traffic increases, everyone is working towards better and more reliable street light control systems [5]. Save more energy and fix errors quickly when they are found with a user-friendly

ITSPWC 2022, May 14-15, Karur, India

DOI 10.4108/eai.14-5-2022.2318871

web application and a mobile monitoring and control system connected to an IoT cloud server. [6], [7]. In this new era of growth as smart cities are being formed, efforts to find optimal energy-based lighting control systems are gaining momentum [8]. Efforts have therefore been made to create reliable and user-friendly applications that make it easy to use and monitor the connected street lights. Smart cities are the concept of connecting the digital technologies in the city and are capable solutions for improving the functioning of services [9], [10]. People driving through those roads may lose the visibility of pits in the road and, in turn, may cause them to face accidents and injuries, which in turn may cause disturbance in their routine. It causes a lot of trouble for society [11], ,[12]. Using a traditional system result in an inefficient, time-consuming, and costly system. The Internet of Things (IoT) implementation in smart cities for street light systems has created many opportunities for the use of information and communication technologies to improve new services and integrate disparate application domains with each other [13], [14]. However, to provide uninterrupted service in the smart city environment, support for all power-limited applications is required.

2System Description

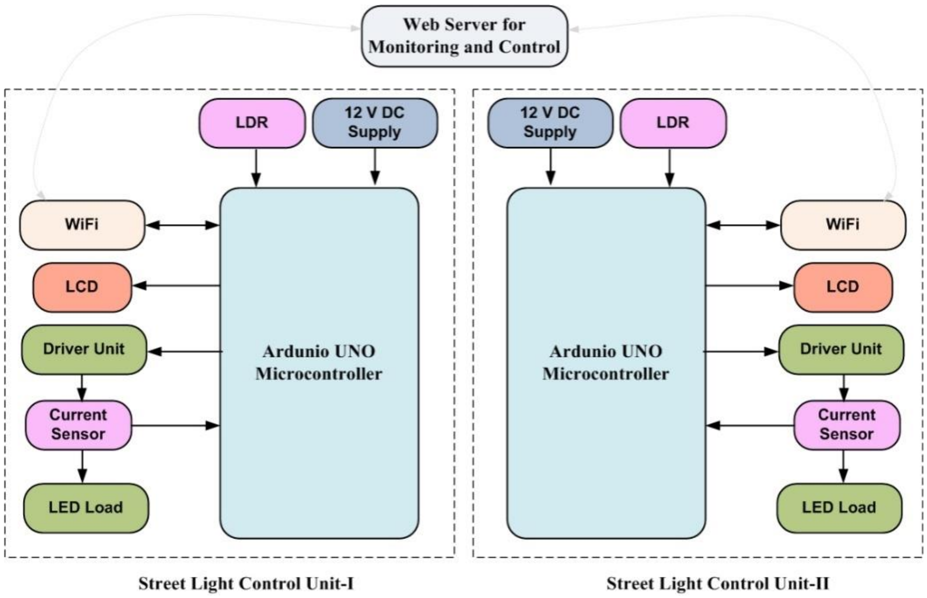

Fig. 1. Block diagram of the proposed system

The proposed system consists of components such as Arduino UNO, LCD, current sensor, LDR sensor, PWM LED driver circuit, power supply, and ESP8266 Wi-Fi Module as shown in Figure 1. Arduino is a prototype platform (open source) based on simple hardware and software. It contains a programmable circuit board (called a microcontroller) and a complete program known as the Arduino Integrated Development Environment (IDE), which is used to write and add computer code to the physical board. The Arduino forums are capable of studying analog or virtual entry alerts from distinct sensors and flipping them into an output along with activating a motor, turning an LED on/off, hooking up with the cloud and different actions.

The liquid crystal display (LCD) is used for monitoring the parameters of the lighting system. The fault detected in the lines can be easily monitored through the LCD. A current sensor senses and measures the current flow to the LED lights. The LDR sensor senses the atmospheric light and sends the data to the controller. The controller sends the signal to the LED driver circuit there by controlling the supply voltage. Electronic equipment requires a reliable power supply to operate. The system uses 12V as input power and can be converted to a 5V output using an IC7805 voltage regulator. The ESP8266 Wi-Fi module is a standalone SOC with a built-in TCP/IP protocol stack that allows any microcontroller to access the Wi-Fi network. The ESP8266 can host applications or download all Wi-Fi network functions from another application processor. The ESP8266 module is a very cost-effective board with a large and growing community. These modules feature rich onboard computing power and storage capabilities, allowing integration with sensors and other application-specific devices via low-load, low-level GPIOs. When the ESP8266 Wi-Fi module is connected to the Arduino controller, the connected street light becomes controlled and monitored through a web application on a mobile phone or laptop.

3Function of the Proposed System

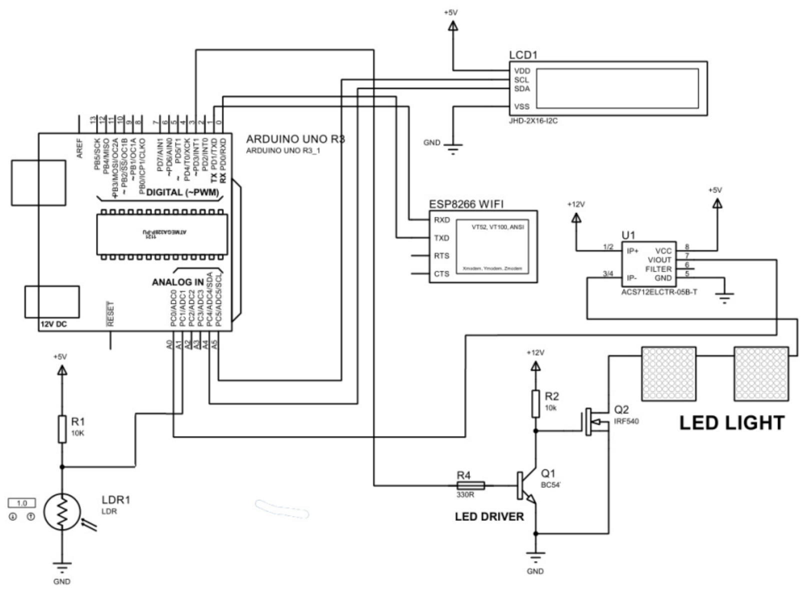

Fig.2. Circuit diagram of the proposed system

The proposed system wirelessly monitors and controls the function of the street lights through a WiFi module interfaced with a controller. The LCD is used to display the performance of the street lights. The most important part of this management is done by the sensors. The current sensor is used for sensing any faults in the supply lines, and the LDR sensors report the atmospheric conditions accordingly to turn on and off the lights using controllers. This results in saving energy usage and improving the efficiency of the system. A WiFi module to transfer the sensed data to the control center. The controller then gives information about the faults in the location to the central monitoring center through the WI-FI module. This makes it possible to maintain the whole street light system in a proper way. The LDR sensor is used for measuring the light intensity and turning on the lights according to the atmospheric light intensity. If there is any fault occurring in the electrical lines, the current sensor will give the message to the controller. The circuit diagram of the proposed street light control system implemented with LED lights is shown in Figure 2. The regulated power supply is required for the controller as well as the led driver circuit. The IC7805 is used as a regulator to maintain a constant output of 5 V DC from the unregulated 12V input. The filtering and regulating system are shown in Figure 3.

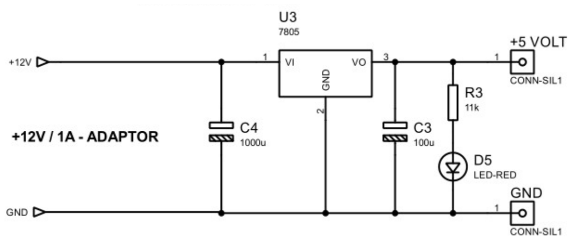

Fig.3. Circuit diagram of the proposed system

4Hardware Description

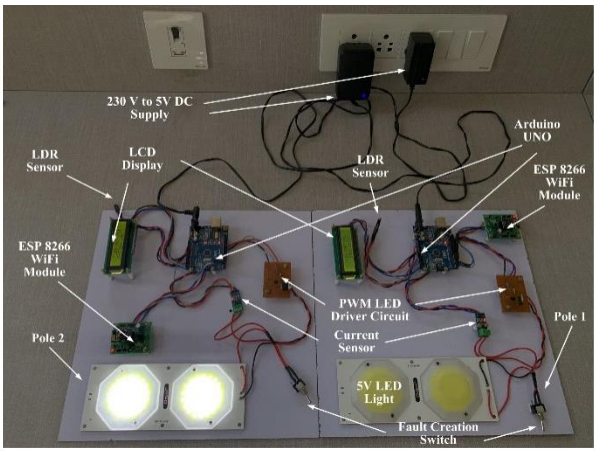

Fig.4. Circuit diagram of the proposed system

The hardware setup of the two-pole street light system implemented for wireless monitoring and control through the Arduino with an ESP8266 WiFi controller is shown in

Figure 4. Each pole consists of two 5W LEDs connected through the PWM driver circuit. The flow of current through the 5W LED is monitored using a current sensor. In addition, it is used for the identification of pole line power flow status. The LCD is interfaced to the controller for monitoring the pole stats, amount of current flow, and power delivery. The two individual pole lines are connected to the power source through a 230 V AC-5 V DC adapter. The LDR sensor monitors the atmospheric illumination and automatically controls the brightness of the LED in order to save energy.

The wireless monitoring and control are implemented with a website made for the monitoring and control process of the pole shown in Figure 5. After a secure login with user name and password, the user can be able to see the next webpage for lamp pole control as shown in Figure 6. From this page, users can control the poles and similarly monitor the pole stats, either function or failure, from the pole status menu.

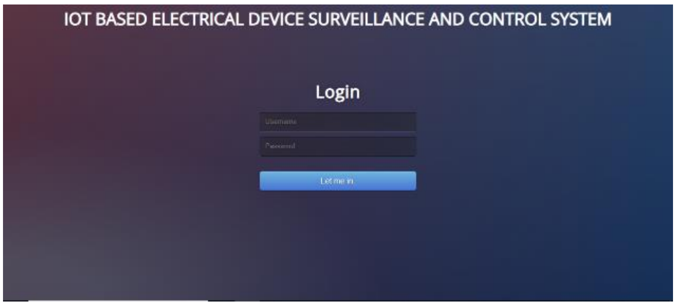

Fig.5. Login page for webpage monitoring and control

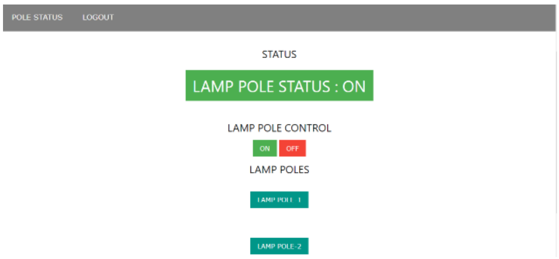

Fig.6. Pole control and status in the website

5Results and Discussion

The wireless surveillance and control of the street light system are controlled and monitored through the website. Initially, connect the Arduino ESP8266 to the mobile hotpot for internet connection. After completing the communication between website and controller, the user can view the pole status at any time. The status is clear, which means there is no problem with the pole or failure in the poles as shown in Figure 7. It is recorded continuously with the date and time. The total power consumption has been recorded at specific time intervals. Hence, the user can simply view the status of the pole. As well, the power consumption is recorded for monitoring the pole performance as shown in Figure8. The LDR sensor is used to control the street light LED brightness very effectively, ultimately reducing the power consumption.

POLE STATUS

DATE	POLE STATUS	CLEAR
2022-01-05 18:45:27	POLE1	CLEAR
2022-01-05 18:45:38	POLE2	CLEAR
2022-01-05 18:49:16	POLE1	CLEAR
2022-01-05 18:53:08	POLE2	CLEAR

Fig.7. Pole status in the website

DATE	CONSUMED POWER (WATTS)	TOTAL CONSUMED POWER (WATTS)
2022-02-21 19:45:09	0.340	4.600
2022-02-21 19:25:39	0.380	4.260
2022-02-21 19:23:47	0.430	3.880
2022-02-21 19:21:38	0.340	3.450
2022-02-21 19:19:46	0.340	3.110
2022-02-21 19:17:37	0.320	2.770
2022-02-20 13:17:30	0.290	2.450
2022-02-20 12:22:40	0.170	2.160
2022-02-20 12:16:47	0.210	1.990

Fig.8. Power consumption in pole 1

Users can control the pole line from the website by operating the pole control. Figure 9 (a) represents the status of pole line 1 in ON condition and pole line 2 in OFF condition. Similarly, Figure 9 (b) represents the status of pole line ON condition and pole line 2 OFF condition. The performance measure of the two poles with respect to power consumption with respect to time and date, along with total consumed power, is recorded continuously and is shown in Figure 10.

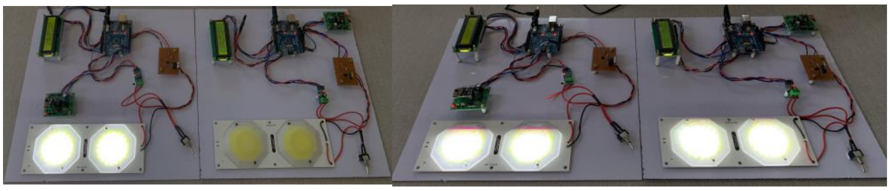

Fig.9. Pole line output result

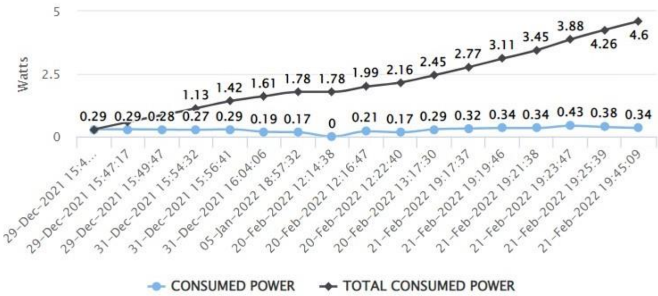

Fig.10. Power consumption waveform

6 Conclusion

This work proposes monitoring and controlling the street light performance and status of the pole line from a remote central location using IoT. The developed system works effectively for indoor and outdoor lighting. This IoT-based street light control system can be controlled and monitored through its web-based control. The wireless technology used in this system controls and monitors all the connected streetlights through a web site. Ultimately, this solved the issues of unorganized and unsystematic maintenance. The developed prototype system results confirmed the effectiveness of the system in reducing power consumption. A user monitored the status and turned off the street lights from a central location, which resulted in the detection of current flow errors and improved the system efficiency.

Acknowledgments

Our gratitude passes on to Dr.V. Kumar Chinnaiyan, M.E., Ph.D. Professor, Head of the Department of Electrical and Electronics Engineering, for his valuable support and encouragement during this project. We are grateful to Dr. C. Pazhanimuthu, M.E., Ph.D. Assistant Professor (Sl.G), Department of Electrical and Electronics Engineering, the project supervisor, for his timely suggestions and constant encouragement and support that led to the accomplishment of the project.

References

[1] Arjun, P., Stephenraj, S., Kumar, N.N. and Kumar, K.N., "A Study on IoT based smart street light systems," *IEEE International Conference on System, Computation, Automation and Networking (ICSCAN)*, pp. 1-7, IEEE, 2019.

[2] Gupta, Alok Kumar, and Rahul Johari, "IOT based electrical device surveillance and control system," *International conference on internet of things: Smart innovation and usages (IoT-SIU)*, pp. 1-5, IEEE, 2019.

[3] Saifuzzaman, Mohd, Nazmun Nessa Moon, and FernazNarin Nur, "IoT based street lighting and traffic management system," *IEEE region 10 humanitarian technology conference (R10-HTC)*, pp. 121-124. IEEE, 2017.

[4] Mathew, Jessin, Riya Rajan, and Rangit Varghese, "Iot based street light monitoring & control with lora/lorawan network," *International Research Journal of Engineering and Technology (IRJET)*, Vol. 6, No. 11, 2019.

[5] Kodali, Ravikishore, and SubbacharyYerroju, "Energy efficient smart street light," *International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT)*, pp. 190-193, IEEE, 2017.

[6] Parkash, Prabu V., and Dandu Rajendra, "Internet of things based intelligent street lighting system for smart city," *International journal of innovative research in science, engineering and technology*, Vol. 5, No. 5, 2016.

[7] Park, Sanguk, Byeongkwan Kang, Myeong-in Choi, Seonki Jeon, and Sehyun Park, "A micro-distributed ESS-based smart LED streetlight system for intelligent demand management of the micro grid," *Sustainable cities and society*, Vol. 39, pp. 801-813, 2018.

[8] Priyanka, S., T. Udaya Lakshmi, and S. Susila Sakthy, "Web–Based Street Light System," *International Conference on Computing and Communications Technologies (ICCCT)*, pp. 159-162, IEEE, 2019.

[9] Rajput, K. Y., GargeyeeKhatav, Monica Pujari, and Priyanka Yadav, "Intelligent street lighting system using gsm," *International Journal of Engineering Science Invention*, Vol.2, No. 3, pp. 60-69, 2013.

[10] Hassan, Mosfiqun Nahid, Mohammed Rezwanul Islam, Fahad Faisal, Farida Habib Semantha, Abdul Hasib Siddique, and Mehedi Hasan, "An IoT based environment monitoring system," *International Conference on Intelligent Sustainable Systems (ICISS)*, pp. 1119-1124, IEEE, 2020.

[11] Ananth, A., S. Danush Venkatesh, G. Kanimozhi, P. MohanBabu, and S. Senthil Arumugam, "IOT based Street Lighting Control System," International Journal, Vol. 8, No. 7, 2020.

[12] Mehmood, Yasir, Farhan Ahmad, Ibrar Yaqoob, Asma Adnane, Muhammad Imran, and SghaierGuizani, "Internet-of-things-based smart cities: Recent advances and challenges," *IEEE Communications Magazine*, Vol. 55, No. 9, pp.16-24, 2017.

[13] Aswatha, A. R., and J. Shwetha, "Streetlight Management and Control System Using IOT," *Applications of Artificial Intelligence in Engineering*, pp. 835-844. Springer, Singapore, 2021.

[14] Sarrab, Mohammed, SupriyaPulparambil, and Medhat Awadalla, "Development of an IoT based real-time traffic monitoring system for city governance," *Global Transitions*, Vol. 2, pp. 230-245, 2020.