

# IoT-Enabled Smart Street Lighting System with Traffic Density Control

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**Abstract**—This paper presents the design and implementation of a Silkworm Disease Detection and Prevention System using IoT technology. The system leverages temperature, humidity, and gas sensors integrated with a NodeMCU ESP8266 microcontroller to continuously monitor environmental conditions in silkworm rearing houses. By setting threshold values for critical parameters, the system detects anomalies that may lead to disease outbreaks in silkworms. The data is transmitted to a cloud-based IoT platform (like ThingSpeak), enabling real-time monitoring and alert notifications. The proposed system aims to reduce silkworm mortality, increase productivity, and support farmers with early warning and prevention mechanisms.

**Index Terms**—Silkworm disease, IoT, ESP8266, DHT11 sensor, gas sensor, ThingSpeak, real-time monitoring, sericulture.

## I. INTRODUCTION

Traditional street lighting systems consume a significant amount of energy by remaining active throughout the night regardless of actual need. With increasing emphasis on smart cities and sustainable development, intelligent systems that adapt to real-time traffic and lighting conditions are gaining importance. This paper proposes a smart street lighting system using ESP32, IR sensors, and LDR, with real-time control and monitoring through the Blynk IoT platform.

## II. LITERATURE SURVEY

In recent years, multiple smart lighting systems have been proposed to reduce energy consumption in urban infrastructure. Traditional systems often rely on time-based automation or simple motion detection using Passive Infrared (PIR) sensors. Some models used timer-controlled lighting systems but lacked

adaptability to real-time traffic conditions. Others involved GSM modules for remote control, which added communication overhead and lacked mobile app integration.

Several IoT-based models were also reviewed, where NodeMCU and Firebase were used for monitoring, but without entry-exit-based light control.

Furthermore, most models did not incorporate traffic density detection using dual IR sensors or combine day/night detection through LDRs.

This indicates a clear gap in systems that offer full real-time control, traffic-based automation, and mobile app-based status monitoring. The proposed system bridges that gap by integrating ESP32, Blynk, IR sensors, and LDRs into a compact, efficient, and scalable smart street lighting solution.

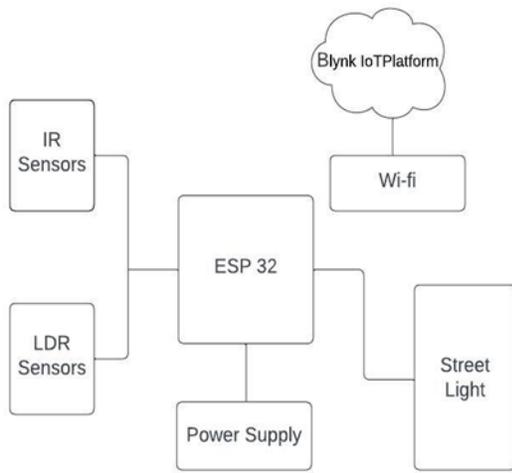
## III. METHODOLOGY

The methodology of the proposed smart street lighting system involves the integration of sensors and a microcontroller to automate light control based on ambient conditions and traffic movement. An LDR sensor continuously monitors the surrounding light intensity to distinguish between day and night. During nighttime, when the ambient light falls below a predefined threshold, the system becomes active. IR sensors placed at the entry and exit points detect the movement of vehicles. Upon detecting a vehicle at the entry point, the ESP32 microcontroller turns the streetlight ON. Once the vehicle passes the exit point, the light is turned OFF, thereby conserving energy. The ESP32 also connects to the Blynk IoT platform via Wi-Fi, enabling real-time monitoring and remote control through a smartphone application. All system states, including light status and sensor activity, are

reflected on the Blynk interface, providing both automation and manual override capabilities.

#### IV. SYSTEM ARCHITECTURE

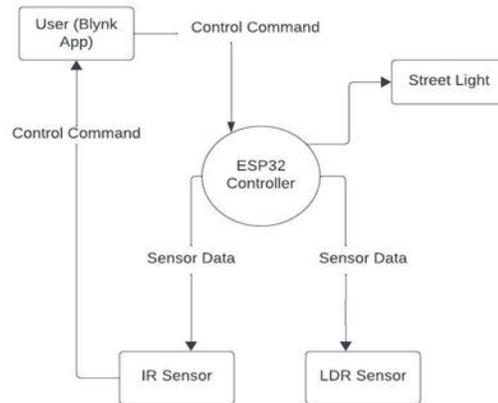
The system architecture of the IoT-Enabled Street Light System with Traffic Density Control integrates hardware and software components for efficient energy management and real-time streetlight control. The ESP32 microcontroller serves as the core, interfacing with IR sensors to detect vehicle presence and an LDR sensor to distinguish between day and night. Based on the sensor data, the microcontroller controls the LED streetlight, turning it on or off. The system connects to the Blynk IoT platform via Wi-Fi, allowing for remote monitoring and control through the Blynk app. A debounce mechanism ensures accurate sensor readings, preventing false triggers. The app provides real-time status updates and allows users to manually control the streetlight if needed. The system optimizes energy usage by turning the streetlight on only when necessary, such as during the night or when traffic is detected. This architecture ensures efficient, automated, and remote-controlled streetlight management.



#### V. SYSTEM DESIGN

The IoT-Enabled Street Light System uses an ESP32 microcontroller, IR sensors for vehicle detection, and an LDR sensor for ambient light measurement. The system automatically controls streetlight operation based on traffic and light conditions, turning the light

on at night or when a vehicle is detected and off when not needed. Integration with the Blynk IoT platform allows remote monitoring and control via a mobile app. The system is energy-efficient and easily scalable, with the ability to add more streetlights or sensors as needed, making it adaptable for urban and rural environments.



#### VI. IMPLEMENTATION

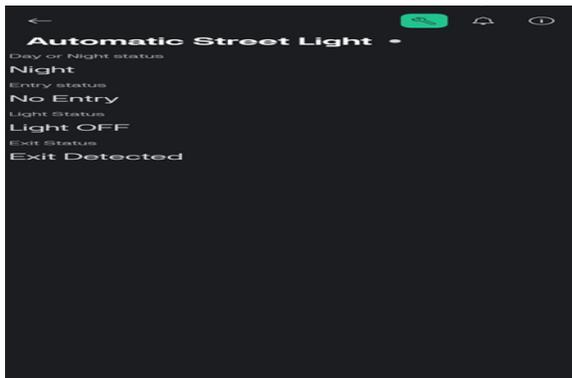
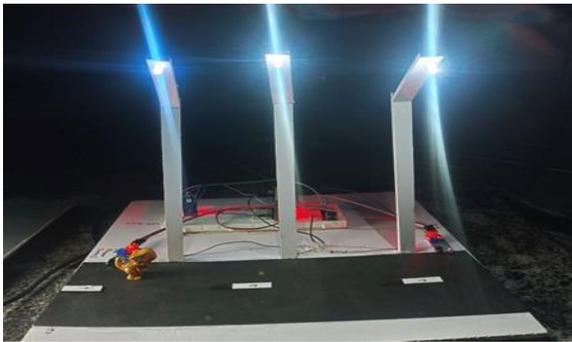
The implementation of the IoT-Enabled Street Light System with Traffic Density Control combines both hardware and software to create an efficient, energy-saving solution for streetlight management. The system uses an ESP32 microcontroller that connects to IR sensors to detect vehicle presence and an LDR sensor to measure ambient light, determining whether it is day or night. The LED streetlight is controlled based on these sensor inputs, turning on when it's dark and a vehicle is detected, and turning off when no vehicle is present or when it's daylight. The ESP32 is programmed using the Arduino IDE and is integrated with the Blynk IoT platform, allowing for real-time monitoring and control of the system via a mobile app. This setup enables users to track the status of the streetlight, receive alerts, and manually control the light if necessary. The system optimizes energy usage by ensuring the streetlight is only activated when required, reducing unnecessary power consumption. The integration of the debounce mechanism ensures accurate sensor readings, preventing false triggers, while the system's energy efficiency is enhanced by using an LED light and controlling the light based on traffic and ambient conditions.

## VII. SCALABILITY AND MODULARITY

The IoT-Enabled Street Light System is designed with scalability and modularity in mind, allowing for easy expansion and customization. As the system is based on the ESP32 microcontroller and utilizes standard sensors like IR and LDR, additional streetlights can be easily integrated by adding more ESP32 units and sensors to the network. The system's modular architecture allows for the addition of more features, such as motion detection, temperature sensors, or integration with other smart city infrastructure, without significant changes to the core structure. By using the Blynk IoT platform, the system supports seamless integration of multiple streetlight units, enabling centralized control and monitoring.

## VIII. RESULTS & IMPLEMENTATION

The system was tested in a simulated environment. It accurately detected entry and exit, adjusted lighting based on the time of day, and updated all statuses on the Blynk dashboard. This confirms that the integration of IR and LDR sensors with ESP32 and Blynk platform offers a cost-effective and efficient smart lighting solution.



## IX. FUTURE SCOPE

The future scope of the IoT-Enabled Street Light System includes the integration of AI and machine learning for traffic prediction, solar power for sustainability, and additional environmental sensors. The system can expand to integrate with other smart city infrastructure, such as traffic management and emergency services, while 5G technology could enhance real-time responsiveness. With scalability in mind, it can eventually manage large city networks, offering an energy-efficient and smart solution for urban lighting.

## X. CONCLUSION

In conclusion, the IoT-Enabled Street Light System with Traffic Density Control presents an innovative, energy-efficient solution for urban streetlight management. By integrating ESP32, IR sensors, and LDR sensors, the system optimizes lighting based on traffic and ambient conditions, ensuring that lights are only active when needed. The addition of Blynk IoT allows for real-time monitoring and remote control, enhancing its functionality. This system is not only scalable and modular but also environmentally friendly, with the potential for future improvements such as AI integration and solar power. As cities move toward smarter, more sustainable solutions, this system represents a significant step toward more efficient urban infrastructure.

## REFERENCES

- [1] Kaur, M., & Singh, H. (2017). Smart Street Lighting System with IoT. *International Journal of Computer Science and Mobile Computing*, 6(4), 241-248.
- [2] Meena, S. (2020). IoT-Based Smart Street Lighting System for Energy Conservation. *Journal of Electrical Engineering and Technology*, 15(3), 1185-1191.
- [3] Gupta, R., & Rathi, M. (2019). Design and Implementation of Smart Street Lighting System Using IoT. *International Journal of Engineering and Technology*, 8(4), 215-223.

- [4] Blynk. (2021). Blynk IoT Platform Documentation. Retrieved from <https://docs.blynk.io/>
- [5] Espressif Systems. (2021). ESP32 Technical Reference Manual. Retrieved from <https://www.espressif.com/en/products/hardware/esp32/overview>
- [6] Kumar, S., & Patel, H. (2018). Smart Street Light System with Solar Power. *International Journal of Engineering Research & Technology*, 7(9), 92-96.
- [7] Sadegh, H., & Bhatia, R. (2019). Wireless Communication for IoT-Based Street Lighting. *International Journal of Computer Science and Information Security*, 17(4), 128-134.
- [8] Patel, P., & Patel, K. (2020). Real-Time IoT Based Street Light System with Automation. *International Journal of Scientific Research and Development*, 8(1), 205-210.
- [9] Singh, R., & Gupta, N. (2017). Smart Street Lighting System Using IoT and Cloud Computing. *International Journal of Computer Science and Information Technologies*, 8(4), 297-301.
- [10] Sharma, A., & Verma, R. (2020). Energy-Efficient IoT-Based Smart Street Light System. *International Journal of Advanced Research in Electrical, Electronics, and Instrumentation Engineering*, 9(3), 1215-1220.
- [11] Kumar, P., & Tripathi, A. (2019). Automatic Street Light Control System Using IoT. *International Journal of Innovative Research in Computer Science & Technology*, 7(2), 45-52.
- [12] Espressif Systems. (2021). Getting Started with ESP32 and Blynk. Retrieved from <https://www.blynk.io/>
- [13] Bharath, S., & Reddy, K. (2018). Internet of Things (IoT) Based Smart Street Light System Using Solar Energy. *International Journal of Electrical Engineering & Technology*, 9(7), 116-122.