

# Smart Street Light Control System using PIR-LDR & Monitoring over Cloud Platform

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**Abstract:** A streetlight, light pole, lamp pole, lamppost, streetlamp, light standard, or lamp standard is a raised source of light on the edge of a road or path. When urban electric power distribution became ubiquitous in developed countries in the 20th century, lights for urban streets followed. Streetlights serve the purpose of security, act as safeguard against road accidents, people feel safer in areas well-lit areas and the crime is also not very prevalent in areas with large number of streetlight. Streetlights have become a necessity in modern world, as there is such a wide utilization of energy by streetlights; we need to come up with ways so that the consumption of energy can be reduced. The streetlights installed currently are mostly outdated and are inefficient. Therefore, there is a pressing need to install streetlights that are efficient and inexpensive. In this article, a smart IoT based Smart Street light system is proposed to satisfy the goal of saving energy through coordinated movements such as infrared (IR) and human detection (PIR). And LDR sensors are also used to detect the presence of light in the space, if there is low light intensity in the outside environment, lights will be turned on. When no one is in the space, the lights will be in dimmed mode or switched off otherwise all lights and are turned to high-light mode. Moreover, setting changes in brightness of LED lights can be directly controlled by microcontroller via IoT. And an app is also created that will connected to the smart lighting system in case if anything gets faulty and there is a need to control the lights manually then that can be done through the app. This approach is very efficient in energy conservation and easy to implement.

**Keywords:** Internet of Things, PIR Sensor, LDR Sensor, ESP32, Smart Street Light

## I. INTRODUCTION

Smart streetlight is considered as a backbone of future. It will play major role energy conservation in smart cities. Smart streetlight system is an interconnected network smart lights which are equipped with lamp controller, sensors, and cameras. A smart light automatically controls the lights based on the brightness, darkness, weather conditions, movement of objects in its vicinity. Thereby, saving a considerable amount of energy and maintenance cost. Smart streetlight may also contain real time data monitoring system which will allow operator to control various functionalities of the streetlights as well as give the insight of the real time data. The technology behind smart streetlights can vary depending on its features and requirements, but typically, it involves a combination of cameras and sensors. When implemented on standard streetlights, these devices can detect movement that enables dynamic lighting and dimming. It also allows neighbouring fixtures to communicate with each other. If a pedestrian or car is detected, all surrounding lights will brighten until movement is no longer captured.

### Scope of Project:

The scope of my project is to develop a IoT based smart streetlight system which can detect human activity and light detection. The streetlights are switched on and off if human or any objects moves in front the lights and if there is no light in the environment. And if there is no light that if there is darkness in the environment and there is no detection of



movement of human or moving objects in the vicinity of the streetlights, the lights are turned dimmed so that it does not consume much energy and hence can save energy efficiently.

### **Objective of Project:**

The objectives of the project are:

1. Enhance energy efficiency: Smart streetlights can adjust their brightness based on the ambient light levels, traffic density, and pedestrian activity, reducing energy consumption and lowering operational costs.
2. Improve public safety: By ensuring adequate lighting levels on the streets, smart streetlights can enhance the visibility of drivers and pedestrians, reducing the risk of accidents and crimes.
3. Reduce maintenance costs: Smart streetlights can detect faults and failures in the lighting system and alert maintenance personnel, enabling quick and efficient repairs and minimizing downtime.

## **II. LITERATURE SURVEY**

- A paper compiled by K. Bhagavan et al. [11] implements the proposed system in a different manner. They have used the Embedded C for the purpose of programming and Keil Uvision as an IDE for the same. Along with the regular components like the relays, IR sensor, LDRs and the WIFI module they also use the 8 bit AT89S52 microcontroller as it is based on the low usage, high output principle. Along with that they have also used the GSM cellular network module for its ability to work in different frequency bands. Overall their system helps in eliminating the traditional street light system in an efficient manner.
- Dr. A. Senthil Kumar, et al. [12] have together contributed a study on IOT-based smart street light systems in which they have different types of sensors for monitoring various parameters. The intensity of light is managed by the LDR sensor, road lights are managed by the IR sensors, and a battery too. They had also placed a CCTV which would record the working of the entire system. Hence the working through the internet, one may access and keep track of how the street light is operating. They also provided an option for help for if something wrong happens then the people can contact the nearby police station immediately.
- A paper by Mahesh Boda et al. [13] in this project, they have implemented an innovative embedded system using NODEMCU ESP8266, RELAY, and LDR sensor components. The aim of the project is to develop a cutting-edge solution for energy-efficient street lighting with reduced costs for maintenance. The system's main objective is to conserve energy by detecting vehicle movement on highways and only turning on the street light that is directly in front of the car, while automatically switching off the trailing lights.
- Parkash et al. [14] have proposed a paper on an Intelligent street lighting for smart cities that is based on the Internet of Things (IoT). The article describes a circuit that turns on the street lights upon sensing vehicle movement and automatically turns them off after a predetermined amount of time. This technology enables the street lights to automatically adjust their timings based on the different periods of the day and night. Using GSM technology, street lights can be manually turned on and off. Additionally, the system adjusts the intensity of the street lights in response to the identification of any object by the PIR sensor, thereby dimming or brightening the lights accordingly. The study focuses on the unique approach of implementing an automated street lighting system using embedded system technologies.
- A research paper by Sangameshwar et al. [15] and was 2020 will see the publication of this research in the International Journal of Advanced Research in Computer Engineering & Technology (IJARCET). The paper proposes a cutting-edge street lighting system that utilizes IoT technology for monitoring and controlling streetlights. The system incorporates sensors, controllers, and cloud-based analytics to optimize energy consumption and enable remote monitoring and control. By leveraging IoT technology, the system aims to reduce energy consumption, improve efficiency, and provide reliable monitoring and control of streetlights. This innovative approach has the potential to revolutionize traditional street lighting systems, making them more energy-efficient, cost-effective, and environmentally friendly.



- The research paper by Dr. H Ravishankar Kamath[16] provides a comprehensive study on the utilization of Internet of Things (IoT) technology for monitoring and controlling street lights. The paper critically reviews the existing literature on the subject, identifying gaps and limitations in the current approaches. The authors extensively review the use of IoT technology in street light monitoring and control, discussing the advantages and limitations of such systems. They also highlight potential future research directions in this field. However, additional information regarding the methodology and criteria used for selecting and analyzing the reviewed studies would be valuable for a more comprehensive understanding of the paper's findings.
- The paper uses a real-time database platform stored in the cloud to suggest a real-time monitoring system for intelligent streetlights. By utilising the automated data synchronisation function of the developed real-time database, the authors, Cheska C[17], show that their system can enable real-time monitoring of data acquired from smart streetlights. Additionally, they use a data filtering method to collect real-time data and avoid using up too much storage. The authors demonstrate through simulations that their suggested Data retrieval from a monitoring system using the Firebase Realtime database is much quicker than from a local web-based monitoring system. The authors recommend future improvements to the integrated technologies, including enhancing the temperature sensor to detect air conditioning and enhancing the microprocessor for better data collection. of components and sensors. Overall, the paper presents a practical and efficient solution for smart streetlight monitoring systems, contributing to the advancement of smart cities.
- The paper discusses the creation and use of an NB-IoT-based smart street lighting system. Through administration platforms, the system offers a number of other functions and allows for the monitoring of individual lights.[18] The authors highlight the potential of the system to serve as a fundamental network platform for smart cities, providing diverse, intelligent, cost-effective, and efficient services. They also suggest the need for further research on control strategies to optimize energy consumption. The authors are affiliated with the Chinese Academy of Sciences, Qingdao Academy of Intelligent Industries, and Beijing Engineering Research Centre of Intelligent Systems and Technology.
- The paper [19] presents a methodology for designing a smart street light system using IoT technology. The methodology includes theoretical analysis, vitality usage, and a smart system. The proposed method aims to address challenges related to power preservation, such as instances where preserved energy is wasted due to sudden changes in weather conditions in the morning, causing the bulbs to switch on unnecessarily. To overcome these issues, the authors have designed a smart streetlight system that utilizes an LDR (Light Dependent Resistor) and is connected to a direct power supply, eliminating the need for sensor dependency on the surrounding area or region. from that.

### III. SYSTEM ARCHITECTURE

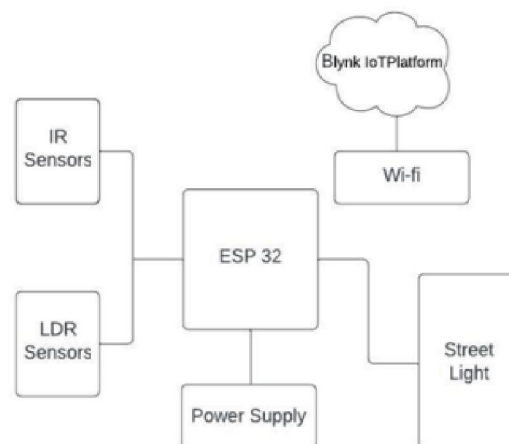


Fig. 1. Block Diagram

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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.

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.

#### A. ESP32:

ESP32 Development board is based on the ESP WROOM32 WIFI + BLE Module. It's a low-footprint, minimal system development board powered by the latest ESP-WROOM-32 module and can be easily inserted into a solderless breadboard. It contains the entire basic support circuitry for the ESP-WROOM-32, including the USB-UART bridge, reset- and boot-mode buttons, LDO regulator and a micro-USB connector. Every important GPIO is available to the developer.

Features:-

- Small volume, easily embedded to other products
- Strong function with support LWIP Protocol, Freertos
- Supporting three modes : AP, STA, and AP+STA
- Supporting Lua program, easily to develop
- Includes CP2102 USB-UART bridge



Fig. 2 ESP32

#### B. PIR Sensor:

A PIR (Passive Infrared) sensor is an electronic device that detects motion by measuring changes in the infrared radiation levels emitted by objects in its field of view. It is a type of motion sensor that is commonly used in security systems, lighting systems, and home automation applications. The sensor consists of a pyroelectric sensor, which generates an electrical signal when exposed to changes in infrared radiation levels, and a processing circuit that interprets the signal and triggers an output signal if motion is detected. One of the main advantages of PIR sensors is their high sensitivity and accuracy. They can detect even small movements within their field of view, making them



ideal for use in security systems and motion-activated lighting systems. They are also able to distinguish between the heat signature of a human and that of other objects, such as pets or moving objects, reducing the likelihood of false alarms. PIR sensors are also easy to install and use. They can be mounted on a wall or ceiling and connected to a control circuit using simple wiring. Most PIR sensors come with adjustable sensitivity and timing settings, allowing users to customize their operation according to their specific needs.

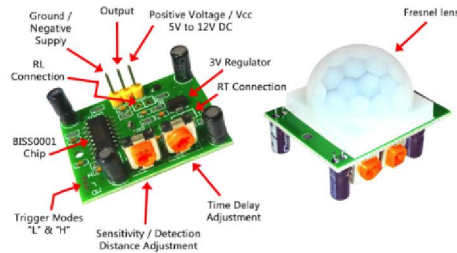


Fig. 3. PIR Sensor

**C. LDR Sensor:**

An LDR (Light Dependent Resistor) sensor is an electronic device that measures the amount of light falling on its surface and changes its resistance accordingly. It is a type of sensor commonly used in light-sensitive applications such as automatic streetlights, outdoor lighting systems, and camera light meters. LDR sensors are made of semiconductor materials that have a high resistance in the dark and a low resistance in the light. The resistance of the sensor varies with the intensity of the light falling on it, which allows it to be used as a light-sensitive switch or as a component in a light measuring circuit. One of the main advantages of LDR sensors is their simplicity and ease of use. They are easy to install and require very little maintenance, making them ideal for use in outdoor applications. They are also relatively inexpensive and readily available, making them accessible to a wide range of users. LDR sensors are also highly accurate and responsive to changes in light levels. They can detect even small changes in light intensity, making them useful for applications where precise control of lighting levels is required. However, there are also some limitations to LDR sensors. They are less effective in situations where the light source is not constant or where there are rapid changes in light levels. They are also less sensitive to changes in color or wavelength of light, which can limit their usefulness in certain applications. In conclusion, LDR sensors are a useful and versatile tool for measuring light levels in a wide range of applications. Their simplicity, accuracy, and ease of use make them a popular choice for outdoor lighting systems, camera light meters, and other light-sensitive applications. While they do have some limitations, they are still an effective and reliable way to measure light levels and improve the functionality of electronic systems.

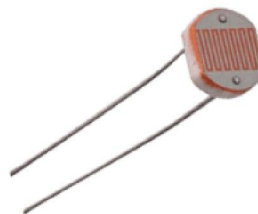


Fig. 4. LDR Sensor



#### **D. Blunk IOT:**

Installation of the Blynk client Android application is made from the Google Play or Appstore for IOS. After the installation on a smart phone is completed, a new account should be created. If a private Blynk server is used, this information should be supplied during the installation. If the Blynk cloud server is used, it is free of charge only for a limited number of widgets. Therefore, for more complex projects (such as this one), it is advisable to use a private Blynk server, which is completely free of charge. In this case, however, the user should provide server installation, configuration and security measures. After a successful login, a new project should be launched, and then defined: the project name, the type of hardware which will be controlled, and the type of connection. After the project is defined, the Blynk server will generate a token which will be used for the authentication during the communication with the server. Blynk is a platform that enables remote control of Arduino, Raspberry Pi, and similar devices over the Internet through iOS and Android apps. The platform offers a digital dashboard with drag-and-drop widgets to create a graphical interface for your project. Setting up Blynk is straightforward, taking only a few minutes, and it supports a wide range of hardware options. Blynk is compatible with devices connected to the Internet through Wi-Fi, Ethernet, or the ESP8266 chip. To set up the Blynk App, users create a project, choose the microcontroller, and create toggle buttons for each relay, linking them to the digital pins of the microcontroller. Blynk then sends an authentication token to the project's registered email address, which should be kept for programming the Node MCU and configuring the IFTTT application.

#### **IV. 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.

Smart lighting technology also employs intelligent control systems that based on signals received by nearby light sensors, control the amount and timing of lighting the bulbs. For instance, the system will switch on the illumination for a person as they travel from one place to another. One of the most significant advantages of smart lighting technology is the 70% reduction in electricity consumption without compromising performance or productivity. It has also transformed the lighting system in cities by adjusting to traffic loads, accidents, and climate changes, thereby improving safety. Smart lighting can reduce electricity consumption, running costs, emissions, and increase the lifespan of lighting sources. By switching from HPS to HID, the efficiency of the system can reach more than 90%.

#### **Future Scope:**

The traditional IoT-based smart street light system has the potential for significant growth and development in the future. Here are some of the potential future scopes of this technology:

- **Advanced analytics:** Smart street light systems can use advanced analytics to monitor traffic patterns, pedestrian activity, and weather conditions, among other factors. This data can be used to optimize lighting schedules, detect faults, and improve energy efficiency.
- **Integration with other smart city systems:** Smart street light systems can be integrated with other smart city systems such as traffic management, waste management, and public safety. This integration can improve the efficiency of these systems and enhance the overall quality of life for city residents.
- **Renewable energy sources:** With the growing need to reduce greenhouse gas emissions and promote sustainable energy practices, there is potential for smart street light systems to be powered by renewable energy sources such as solar or wind power.



- Autonomous operation: The future of smart street light systems may involve the use of autonomous operation, where the lights can adjust their brightness based on ambient light levels, traffic patterns, and pedestrian activity. This can improve energy efficiency and reduce costs.
- Improved communication: Smart street light systems can be used as communication hubs, providing Wi-Fi, mobile data, and other wireless services to city residents. This can help to bridge the digital divide and provide access to information and services for all. Overall, the future scope of traditional IoT-based smart street light systems is vast, and their potential benefits to society are significant.

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