International Journal of Technology, Leadership and Sciences (IJTLS)
ISSN: 3107-9083 www.ijtls.com Paper ID: TLS-26/V2/I2-003
DOI: https://doi.org/10.5281/zenodo.19093220

# SENSOR AND IOT-BASED SMART STREETLIGHT CONTROL SYSTEM WITH REAL-TIME MONITORING

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**ABSTRACT:** The intelligent street light system, based on the Internet of Things (IoT), seeks to conserve energy by reducing power wastage and labor costs. The energy conserved in residential and commercial environments has numerous applications. An LDR sensor is utilized when deemed suitable. The LDR sensor modulates the street light's intensity based on the ambient light level. It is a basic switch that operates in both illuminated and dark conditions due to a relay positioned at the terminus. Upon acquiring the LDR value, the cost-effective ESP8266 WiFi module is equipped to execute this transfer. Internet users can obtain real-time information regarding the condition of street lighting. It appears to be exceptionally steady and reliable over the long run. This is achieved by utilizing a NodeMCU board programmed to emit the correct intensity of light at the designated times. The suggested task is more efficient than the existing system.

***KEYWORDS***: IoT, LDR Sensor, Relay, Wi-Fi module ESP8266, NodeMcu

## 1. INTRODUCTION

Electricity is often used to light up city streets. Local governments can save fifty to seventy percent on street lighting expenses by implementing a system. By accurately distinguishing between vehicles, pedestrians, and bicycles, the smart street lighting system can adjust the illumination levels for each. The primary objective of the research is to employ instruments that measure the intensity of light. A power conditioning and control program-using wireless gadget regulates energy consumption.

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The effectiveness of streetlights may be monitored in real time by anyone with an internet connection, regardless of their location. Connecting the pillar light to the ESP8266 NodeMCU street driver is a must. The streetlight actuator may communicate with the base station wirelessly, allowing for easier system tracking. The methods can be configured to run automatically or manually. The control system can determine the on/off times and adjust the brightness of the streetlight.

## 2. LITERATURE SURVEY

A multifunctional prototype is frequently included in the project. It might potentially take the place of the current human-operated street lighting system. The objective is to reduce energy consumption and maintenance costs associated with street lighting by developing and implementing cutting-edge embedded systems that make use of existing technologies. The Street Lightning system consists of two sensors. Both the passive infrared sensor (PIR) and the light-dependent resistor (LDR) are used to measure the amount of light in the area.

Among the many economical and highly regarded built-in Wi-Fi processors for the Internet of Things, the ESP8266 stands out.

On this section. An integrated 32-bit Tensilica Xtensa L106 CPU powers it. Front end modules eliminate the need for additional external electronics by consolidating them onto a tiny PCB size. These modules include an RF balun, low noise receive amplifier, power amplifier, filters, and power management.

The Automatic Street Light Control System completes its task quickly and easily. These components enable an automated motion when coupled with a relay. The rise of automation has reduced the demand for human labor. When night falls, the lights will automatically switch on in this manner. A light-dependent resistor (LDR), which mimics the way our eyes see light, is utilized in the process. The moment the sun comes up, all the artificial lights are immediately shut off. Another advantage of this strategy is that it might assist save energy.

The software attempts to conserve energy by activating the street lights in the vicinity of the vehicle and deactivating them behind it. This is accomplished by detecting when a vehicle is present on the road. No matter how dark it gets, every light on the street remains turned on. To do this, a significant quantity of energy is required.

An IoT gadget transmits crucial time data to the cloud via a Wi-Fi ESP8266 module. Cities and towns rely on expensive street lighting. Energy prices might rise by 10–38% in areas hit by lightning strikes.

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## 3. IMPLEMENTATION

Promoting IoT-based smart street lighting systems is the overarching objective of these initiatives. To improve the management of our street lighting, we have decided to implement THING SPEAK technology. The components utilized in this project are an ESP8266, a NODEMCU, a switch, and an LED sensor. The most significant challenge that India has is managing its street lighting infrastructure. Because streetlights in India are manually repaired during the day, this process consumes energy. The development process is made easier and more error-free using Thingspeak by improving interactions.

**Block Diagram**

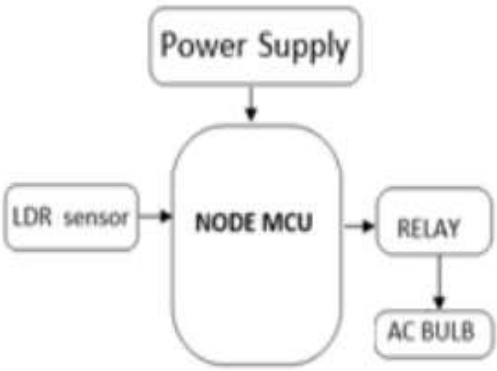


Figure 1: Block Diagram

**Equipment used**

- Power supply
- LDR sensor
- NODEMCUESP8266
- Relay
- Bulb

**Power Supply**

A "power supply" is defined as the origin of an energy source. A power supply unit (PSU) is a device that converts variable-use electricity from one form of energy source to another. Power sources are the most common subjects covered by this phrase. When discussing mechanical energy or alternate energy sources, it is hardly utilized. The primary function of this component of the power supply is to convert AC current into DC current, therefore reducing energy consumption.

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The volume of the noise. With a primary voltage output of 230V/50Hz, an alternating current voltage is produced. Some jobs require a direct current (DC) voltage of +5V or +12V, though.

**NODEMCUESP8266**

The NodeMCU framework allows for the creation of open-source hardware and applications. This device is constructed using the low-cost ESP8266 System-on-Chip (SoC). It is necessary to develop the software in a machine code language that is compatible with the hardware of the chip. One low-cost WiFi microcontroller that's up to the task of managing a lot of TCP/IP traffic is the ESP-8266. Connecting the Internet of Things interface to the web becomes much easy with this. The ESP8266 has many special WiFi functions.

- Supports both WPA and WPA2 security standards, and it works with 802.11 b/g/n Wi-Fi at 2.4 GHz.
- Twelve standard GPIO inputs and four standard GPIO outputs are at your disposal.
- Inter-Integrated Circuit (I2C) interfaces allow for serial transfer.
- A 10-bit analog-to-digital converter (ADC) is employed for the purpose of converting analog signals into digital signals.
- Devices can communicate with one another serially over the Serial Peripheral Interface (SPI).

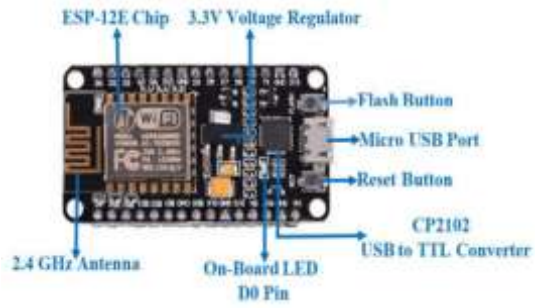


Figure 2: WiFi module ESP8266

**LDR sensor**

Electronic components that undergo a change upon illumination are known as photoresistors or light-dependent resistors (LDRs). These are commonly utilized for the purpose of detecting the presence of light or quantifying its intensity. A light-sensitive sensor, the Light Dependent Resistor (LDR) can detect and respond to light. Since the LDR produces an analog signal, it is linked to the Arduino's analog input port. In order to translate voltages between 0 and 5 volts into digital integers between 0 and 1023, the Arduino uses an analog-to-digital converter (ADC).

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Figure 3: Light Dependent Resistor (LDR) sensor

**Relay Board**

A relay board is an electrical device with numerous connections and switches. They make it easy to modify the power source voltage with their built-in input and output connections. With a relay board, you can set up and operate numerous separate relay channels all at once.

Electric switches and relays can activate or deactivate power when low voltages, such as 5V from the NodeMCU pins, contact them. The NodeMCU has the ability to control multiple relays and other outputs.

Electromechanical buttons often use an electric current to operate. The starting and stopping of a wire are determined by the current that runs through it. Relays are versatile and dependable, much like the buttons on a remote control. Various forms of trade exist. It is not uncommon for systems that rely on hydraulic or gas power to be coupled with electrical ones. The input and output can be switched between mechanical and electrical modes. A relay has two separate purposes. The majority of applications are both low-voltage and high-voltage. In low-voltage settings, reducing circuit noise is essential. Their main purpose is to keep things from arcing when there are significant electrical currents present.


Figure 4: Relay Board

**Bulb**

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The energy consumption of conventional light bulbs is significantly higher than that of LEDs. Illuminate the paths. Compared to incandescent light bulbs, LEDs consume roughly 75% less energy. Also, LEDs have what's called the "hassle factor," which makes them last a lot longer for the same initial investment.

Figure 5: Bulb

## 4. SOFTWARE REQUIRED

**Arduino IDE**

The Arduino software is free and open-source, making it straightforward to develop code and communicate it to the device. Each operating system—Windows, Linux, and Mac OS X—functions independently on computers. Despite lacking the Java IDE and application, it is compatible with all Arduino boards due to its Java basis.

**Thingspeak**

Real-time data collection, visualization, and analysis are made simpler with the ESP8266 Thingspeak analytical IoT tool. Data is transmitted and received in the cloud. When it comes to the Internet of Things (IoT), ThingsSpeak is an open-source, free, and app that objects may use to communicate with one another and share data through a local area network or the internet. The protocols used are MQTT and HTTP. Displaying a real-time-updated unofficial community of things, area monitoring systems, and component construction kits are all possible with the ThingSpeak license.

**Advantages**

- Reduced healthcare expenses
- Lower the damage that light does to the world around us.
- Using strategies to reduce energy consumption
- The installation of lighting systems significantly reduces the likelihood of crimes such as murder, theft, and others.

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- Staffing levels fall short.
- The region becomes safer and the likelihood of something unpleasant happening decreases when the streets are lit up.

## 5. WORKING

The "Internet of Things" is a network of interconnected computing devices that enables novel online experiences. They might link an intelligent gadget to the system's data network and provide it understandable information. Connectivity and interoperability across all components of this system is critical for compliance with the Internet of Things (IoT) standard.

The modular system is constructed with a NODEMCU ESP8266, LEDs, switches, and LDR sensors. Here, the machine's intelligence comes from the NODEMCU processor. This strategy makes advantage of any and all sensors that a computer is capable of connecting to. Contrast photoresistors using light-emitting diodes. The light source loses its effectiveness and resistance when exposed to sunlight. The sensor's resistance increases in the dark, causing the light to glow. With the right connection between the microprocessor and the relay driver, the relay can toggle between electromagnetic and mechanical modes. When turned on and off, the lighting system is incredibly effective.

**Flowchart of working system**

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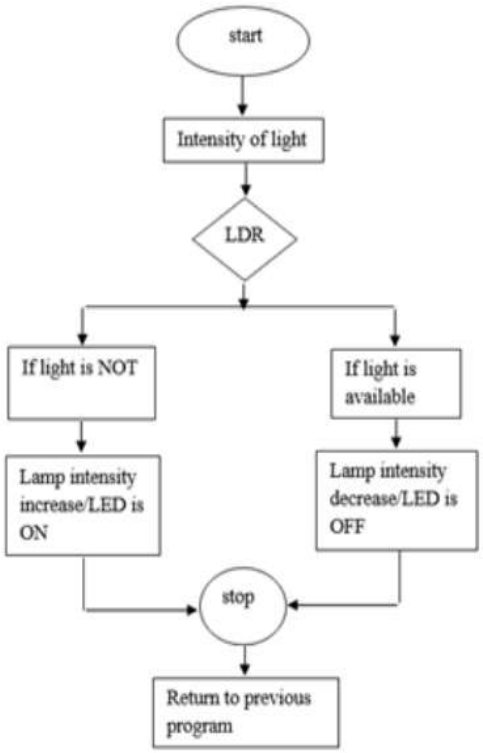


Figure 6: Flowchart of working system

## 6. RESULTS AND ANALYSIS

Figure 7: Prototype of the IoT based smart street light system

**Scenario during Day under Full Brightness**

The ambient light is so intense that the LED remains inactive and the LDR value remains constant throughout the day. An object's brightness is proportional to the amount of light that reaches it.

**Scenario during Night under Full Darkness**

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The LDR mode activates and all of the LEDs light up at night when there is no external light.The LDR's insensitivity to light un low light conditions results in a relatively constant value. The LDR number is displayed in Table 1. One may occasionally use the intensity number to characterize the brightness of an external light source. Table 1 has a chart that you can utilize.

Figure 7 illustrates this.The graph clearly shows that there is a direct correlation between the amount of light coming from the outside and the brightness of the LEDs. The amount of ambient light has a direct correlation to the efficiency of light-emitting diodes (LEDs). Its power is greatest just now, as night falls.

Table 1: External Brightness vs Led intensity

| *External Brightness* | *LED Intensity* |
|---|---|
| 62 | 514 |
| 54 | 534 |
| 51 | 542 |
| 210 | 119 |
| 211 | 117 |

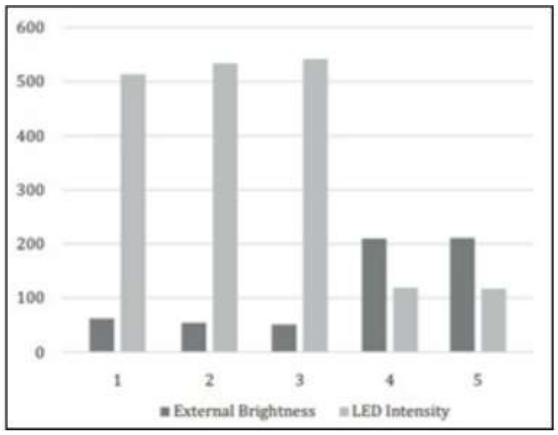


Figure 8: Brightness Vs Intensity

## 7. CONCLUSION

The proposed solution outshines the existing system in terms of ease of setup, maintenance requirements, and user experience. Improving this method may be as simple as adding logic to the code. You can program the streetlights to turn on when it becomes dark and off when it gets light. In addition, it might utilise data from a reliable weather station to determine the exact beginning times of dawn and dark. This will reduce the frequency with which individuals need to be stationed there; in the event of an emergency, their presence at the street light will be mandatory. Manual systems are inferior than their automated counterparts.

By having them modified to our specifications, we can make these devices work for us perfectly. All of the generated data is stored in the Thingspeak database, and you can access it later with the API key.

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