Smart Street Light System Based on IOT

A

Project Synopsis

Report

Submitted in the partial fulfilment of the requirement for the award of

Bachelor of Technology

in

IoT & Intelligence System

By:

Yuvraj Singh (219311001)

Aryan Kuldeep Dadeech (219311004)

Under the supervision of:

Dr. Sandeep Kumar Sharma

MANIPAL UNIVERSITY
JAIPUR

August 2023

Department of IoT & Intelligence System
School of Computer and Communication Engineering
Manipal University Jaipur
VPO. Dehmi Kalan, Jaipur, Rajasthan, India – 303007

ABSTRACT

The project aims to design and implement an IoT-based smart street light system that efficiently manages street lighting using sensor networks and IoT technology. Leveraging the capabilities of IoT technology, the system introduces intelligence, adaptability, and energy efficiency into traditional street lighting networks. The system is designed to optimize energy consumption, reduce maintenance costs, and improve overall safety and sustainability in urban areas.

Keywords

Internet of things (IOT); Streetlights; Google Maps.

1.INTODUCTION

In our rapidly urbanizing world, the demand for efficient, sustainable, and intelligent infrastructure has become increasingly paramount. Among these infrastructural needs, street lighting stands as a critical component, influencing public safety, energy consumption, and urban development. Traditional street lighting systems often suffer from inefficiencies in energy consumption and maintenance, prompting the exploration of smarter, more adaptive solutions.

The advent of the Internet of Things (IoT) has revolutionized various sectors by enabling the interconnectivity of devices and systems, offering unprecedented opportunities for innovation. In this context, the implementation of an IoT-based smart street light system emerges as a promising solution to address the shortcomings of conventional street lighting.

The primary objective of this project is to design, develop, and implement an IoT-based infrastructure tailored for street lighting. By leveraging sensors, advanced data analytics, and remote-control capabilities, this system aims to intelligently manage street lighting in real time. This intelligent control mechanism will respond dynamically to environmental factors such as ambient light levels, motion detection, and traffic patterns.

OBJECTIVES

- To develop an IoT-based infrastructure for smart street lighting.
- To integrate sensors for detecting ambient light, motion, and traffic flow.
- To automate the adjustment of street light intensity based on real-time conditions.
- To enable remote monitoring and control using a web or mobile application.

2.LITERATURE SURVEY

Smart streetlight monitoring system using Xbee wireless module. Their aim is to monitor the health of streetlights and forward monitored result to the control station. Inside the lamp module, it consists of light dependent resistors (LDR) module, microcontroller module and transmission module. The lamp module will communicate with the control centre through wireless using Xbee. In the LDR module, it consists of two LDR. One of the LDR is install on top of the streetlights for the checking the day/night status condition. Another LDR is place under the streetlights to monitor and checking the lamp health status. The results of the LDRs send to microcontroller, where the microcontroller will process the data and send the data to the transmission module. In the transmission module, there is wireless Xbee that transmit the data through wireless to the control centre. In the control centre, it will monitor each of the streetlight status, as well as controlling the operation of the street lamps. Automatic Street Light Control System Using Microcontroller, this paper aims at designing and executing the advanced development in embedded systems for energy saving of streetlights. Nowadays, human has become too busy, and is unable to find time even to switch the lights wherever not necessary. This paper gives the best solution for electrical power wastage. Also, the manual operation of the lighting system is completely eliminated. In this paper the two sensors are used which are Light Dependent Resistor LDR sensor to indicate a day/nighttime and the photoelectric sensors to detect the movement on the street. The microcontroller PIC16F877A is used as brain to control the street light system, where the programming language used for developing the software to the microcontroller is C-language.

Traditional street lighting systems, with their fixed lighting schedules and lack of real-time monitoring capabilities, face significant challenges in terms of energy efficiency, adaptability, and public safety. The emergence of the Internet of Things (IoT) has opened up new avenues for transforming urban infrastructure, including street lighting, into a more intelligent and responsive system. IoT-enabled smart street light systems utilize a network of interconnected devices to collect real-time data, analyze traffic patterns, and

optimize lighting levels, offering a promising solution to address the limitations of traditional street lighting.Conventional street lighting systems are characterized by several drawbacks. Inefficient Energy Consumption. Fixed lighting schedules often result in excessive energy usage, contributing to unnecessary costs and environmental impacts. Limited Adaptability: Traditional systems lack the ability to adjust lighting levels based on real-time conditions,leading to over-illumination in certain areas and under-illumination in others. Lack of Real-time Monitoring: The absence of real-time monitoring capabilities hinders proactive maintenance and timely response to malfunctions. These challenges present significant opportunities for improvement through the integration of IoT technology. Energy Efficiency: IoT-enabled smart street lights can dynamically adjust lighting levels based on real-time data,reducing energy consumption by up to 50% or more. Adaptive Lighting: Smart street lights can adapt to real-time conditions, such as traffic flow, weather, and pedestrian presence, ensuring optimal lighting levels and reducing unnecessary energy use. Real-time Monitoring and Maintenance: IoT systems enable real-time monitoring of street light performance,facilitating proactive maintenance and timely repair of faults. Benefits of IoT Integration in Smart Street Light Systems. The adoption of IoT technology in smart street light systems offers a multitude of benefits. Energy Savings: Significant energy savings can be achieved through adaptive lighting control and optimized scheduling. Environmental Impact Reduction: Reduced energy consumption translates to lower greenhouse gas emissions,contributing to environmental sustainability. Enhanced Public Safety: Improved illumination in poorly lit areas can deter criminal activity and enhance pedestrian safety. Improved Traffic Management: Smart street lights can integrate with traffic management systems to optimize lighting levels based on traffic flow, reducing congestion and improving road safety. Environmental Monitoring: Sensors integrated into smart street lights can collect data on air quality, noise levels,and other environmental parameters, providing valuable insights for urban planning and environmental management.

3.Hardware and Software Requirements

The idea of this project is to give information about the IOT SMART STREET LIGHT SYSTEM. So, we have chosen the THING SPEAK technology to get more control over the street lighting. In this project we are interfacing NODEMCU ESP8266, RELAY &LDR SENSOR.

India facing one of the major Problem is maintenance of streetlights. In India streetlights are maintained manually, it is found that there is wastage of power by operating the streetlights due to manual operations like switch on the light at day time. To reduce the manual errors by controlling, implementation is done using Thingspeak for effective communication.

3.1 Block Diagram

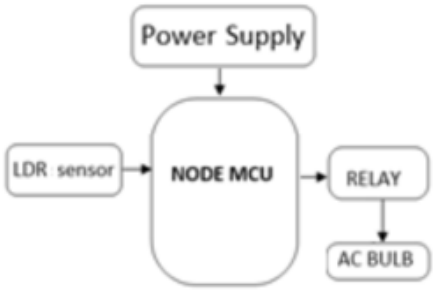

Fig 1.

3.2 Equipment used

- Power supply
- LDR sensor
- NODEMCUESP8266
- Relay

- Bulb

3.3 Power Supply

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. This power supply section is required to convert AC signal to DC signal and also to reduce the amplitude of the signal. The available voltage signal from the main is 230V/50Hz which is an AC voltage, but the required is DC voltage with the amplitude of +5V and +12V for varies applications.

3.4 NODEMCUESP8266

The NodeMCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK.

- 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2).
- General-purpose input/output (16 GPIO).
- Inter-Integrated Circuit (I2C) serial communication protocol.
- Analog-to-digital conversion (10-bit ADC).
- Serial Peripheral Interface (SPI) serial communication

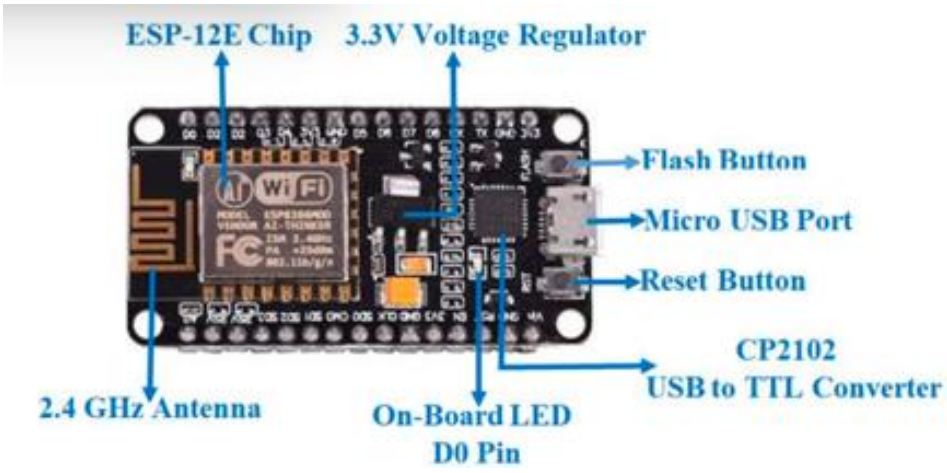

Fig 2.

3.5 LDR sensor

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase

in the intensity of light.The Arduino, with its built-in ADC (analog-to-digital converter), then converts the analog voltage (from 0-5V) into a digital value in the range of (0-1023).

Fig 3.

3.6 Relay Board

A relay board is an electronic device that consists of several relays, usually arranged in a single unit or board. Relays are switches that are electrically operated, allowing a low-power signal to control a higher-power circuit. The relay board provides a convenient way to manage multiple relays within a single module.A relay is an electrically operated switch that can be turned ON or OFF, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the NodeMcu pins. Controlling a relay module with the NodeMcu is as simple as controlling any other output.

Fig 4.

3.7 Bulb

Bulbs are devices that produce light by converting electrical energy into visible light. Over time, various types of bulbs have been developed, each with its own characteristics, efficiency, and applications.

Fig 5.

Software Required

Arduino IDE

The Arduino Integrated Development Environment (IDE) is an open-source software platform used to write and upload code to Arduino microcontroller boards. It provides an interface for writing, compiling, and uploading code to Arduino-compatible devices.

Thingspeak

ESP8266 ThingSpeak is an Internet of Things (IoT) platform developed by MathWorks, the company behind MATLAB and Simulink. It's a cloud-based platform that enables users to collect, store, analyze, visualize, and act on data from IoT devices or sensors.

4.Proposed Methodology

An IoT-based smart street light system operates by integrating sensors, such as light, motion, and temperature detectors, throughout urban areas. These sensors collect real-time data about the environment and communicate wirelessly with a central control system. This central hub processes the data, enabling intelligent decision-making regarding the brightness of streetlights. The system autonomously adjusts light intensity based on factors like motion detection, ambient light levels, and overall activity, optimizing energy consumption. Remote monitoring and control allow administrators to oversee the system, receive maintenance alerts, and make manual adjustments as needed. The integration of these technologies not only enhances energy efficiency but also contributes to cost savings and improved management of urban infrastructure, making the streets safer and more sustainable.

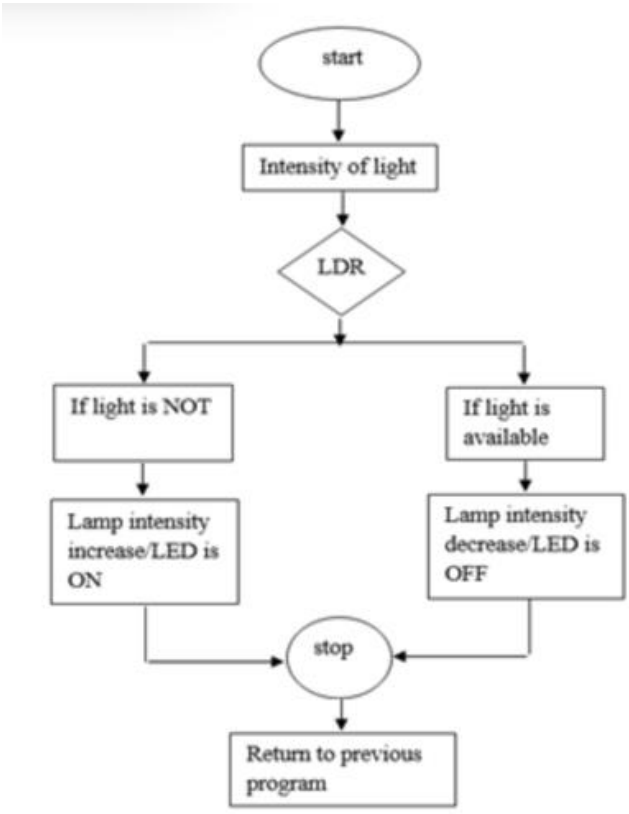

Fig 6.

Algorithim used

```
import time

class SmartStreetLightSystem:
    def __init__(self):
        self.light_intensity = 0

    def adjust_light_intensity(self, motion_detected, ambient_light_level):
        if motion_detected or ambient_light_level < 50:
            self.light_intensity = 100
        else:
            self.light_intensity = 30

    def remote_monitoring(self):
        print(f"Current Light Intensity: {self.light_intensity}%")

    def run_system(self):
        while True:
            motion_detected = self.detect_motion()
            ambient_light_level = self.measure_light()
            self.adjust_light_intensity(motion_detected, ambient_light_level)
            if self.light_intensity == 0:
                self.generate_maintenance_alert()
            self.remote_monitoring()
            time.sleep(5)

    def detect_motion(self):
        return True

    def measure_light(self):
        return 40

    def generate_maintenance_alert(self):
        print("Maintenance Alert: Replace Light Bulb")

street_light_system = SmartStreetLightSystem()
street_light_system.run_system()
```

Advantages

- Maintenance cost reduction
- Reduction of light pollution
- Energy saving Lightning system also reduces crime say murder, theft and plenty of more to a great- extend.
- Reduction of manpower

- Major advantages of street lightning include prevention of the accidents and increase in the safety.

5.Experimented Results and Analysis

Scenario during Day under Full Brightness
At daytime due to full environmental brightness, no LEDs are ON and the value of LDR remains almost constant. The intensity varies depending on brightness.

Scenario during Night under Full Darkness
At night due to zero environmental brightness, all LEDs are ON at their full intensity and the value of LDR here too remains almost constant as the LDR would not sense any light all night. Table1 shows the value of LDR which is referred as external brightness and on the other hand the value of intensity. Looking at the table we could say that as the external brightness increases the intensity of the LEDs decreases and as the external brightness decreases the value of LEDs increases. When it is totally dark outside the Intensity reaches to the peak.

Table 1: External Brightness vs Led intensity

External brightness	LED intensity
62	514
54	534
51	542
210	119
211	117

6.Conclusion and Future Scope

The proposed system is easy to setup and implement and it doesn't require extra maintenance compared to the already existing system. This system can be further enhanced by writing logic into the code and that can be able to retrieve information of the time of sunset and sunrise from a reliable weather reporting source and automate the process completely by turn ON the streetlight at the time of sunset and turn it OFF by sunrise. This further eliminates human intervention and a manual visit to the location of the streetlights will be required only in case of a malfunction. The efficiency of automated systems is more than the manual systems. We can also reprogram these devices with respect to our needs. By using the API key, the generated data is stored in Thingspeak database which we can use for future references. With the use of data from several sensors and devices, this system aims to build a smarter, more connected city where street lighting is intelligently maintained and controlled in real-time. This can enhance the overall user experience and quality of life in the city while also optimising energy use, cutting expenses, and minimising maintenance requirements. We are suggesting a model that can carry out the following tasks: Differentiate between humans and animals and Power Saving Mode

7.References

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