**Automatic Street Light System**

**Microprocessor System and Interfacing Project Report**



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## **1.ABSTRACT**

This project presents the development of a smart street lighting system using the ESP32 microcontroller. The system automatically turns street lights ON/OFF based on ambient light intensity using an LDR sensor. Manual override functionality is provided through Bluetooth, allowing users to remotely control the lights for a defined duration. Additionally, an OLED display is integrated to provide visual feedback of the current system state. The system demonstrates how intelligent lighting can reduce energy consumption and improve urban infrastructure.

## **2. INTRODUCTION**

Automating street lighting is crucial in modern urban planning to conserve energy and reduce maintenance efforts. This project uses sensor-based technology coupled with wireless communication to manage street lights efficiently. By implementing this system, light control becomes adaptive and responsive to environmental conditions, eliminating the need for manual operation.

## 2.1. MOTIVATION

Manual street light control often leads to energy wastage due to delayed switching. Moreover, some areas remain underlit or overlit regardless of need. With this project, we address such inefficiencies by leveraging the ESP32 and IoT components to introduce a more intelligent system.

## 3. OBJECTIVES

* Automate street lights using an LDR sensor.
* Provide manual override through Bluetooth.
* Use OLED for real-time status display.
* Demonstrate the system's scalability with multiple LEDs.
* Conserve energy through intelligent control.

## **4. PROJECT IMPLEMENTATION**

## 4.1. COMPONENT DETAILS

* **ESP32**: Microcontroller with built-in Bluetooth.
* **LDR Sensor**: Detects ambient light.
* **OLED Display**: SSD1306 displays system messages.
* **LEDs**: Simulate street lights.
* **Bluetooth (SerialBT)**: Enables manual control.
* **Power Supply, Breadboard, Resistors, Wires**: Standard prototyping materials.

## **4.2 Working Principle**

* The LDR sensor detects the level of ambient light.
* When it's dark (LDR output is HIGH), LEDs turn ON.
* When it's bright (LDR output is LOW), LEDs turn OFF.
* The current system status is displayed on an OLED screen.
* Manual Bluetooth commands (‘X’ to turn ON, ‘Y’ to turn OFF) can override the automatic operation for 10 seconds.

## 4.3 Project Image

## **5. Code Explanation**

Key Features:

* **LDR Sensing**: digitalRead(LDR\_PIN) checks light.
* **LED Control**: digitalWrite(LED\_PIN, HIGH/LOW) sets state.
* **Bluetooth Input**: SerialBT.read() reads commands ‘X’ or ‘Y’.
* **OLED Display**: Displays messages using display.println().

Override Logic:

* On receiving 'X', manual override is set true, LEDs turned ON.
* On receiving 'Y', override is set true, LEDs turned OFF.
* After 10 seconds, automatic LDR control resumes.

## **6. Bluetooth Manual Override Feature**

Bluetooth integration allows:

* Remote activation of lights using mobile.
* Commands:
  + **‘X’** – Turns LEDs ON manually.
  + **‘Y’** – Turns LEDs OFF manually.
* Manual mode is active for 10 seconds before reverting to auto mode.
* Ideal for situations where remote override is needed (e.g., maintenance, temporary lighting).

## **7. OLED Display Functionality**

The SSD1306 OLED provides:

* Real-time display of system state.
* Messages like:
  + “LED IS NOW ON”
  + “LED IS NOW OFF”
  + “Manual LED ON/OFF”
* Helps in debugging and improving user interaction.
* Uses I2C protocol for communication with ESP32.

## **8. RELATED WORK**

Several systems have been proposed for automating street lighting using microcontrollers, IR sensors, or timers. However, many lack real-time manual control or visual feedback. This project improves on prior work by combining ambient light detection, Bluetooth control, and OLED display for a complete smart lighting solution.

## **9. Applications and Benefits**

### Applications:

* Street lighting in cities and remote areas.
* Campus and industrial area automation.
* Home garden or boundary wall lighting.

### Benefits:

* Energy efficiency by avoiding manual switching.
* Smart control based on environmental lighting.
* Remote operation for added convenience.
* Scalable and customizable for multiple zones.

## **10. Conclusion**

This project showcases a smart and energy-efficient street lighting solution using ESP32. It dynamically responds to environmental light and provides remote control functionality via Bluetooth. The OLED display adds user-friendly status feedback. Using multiple LEDs demonstrates how such a system can scale across various sections, making it ideal for large-scale implementation. The project highlights a practical blend of embedded systems, sensor interfacing, and wireless communication.