CSE7101- Capstone Project

Review-3

AUTOMATIC PUBLIC LIGHTNING SYSTEM

Batch Number:CSE_60

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Name of the Program: **Capstone Project**

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Abstract

An energy-efficient automated public lighting system is proposed using ESP-NOW — a low-power, low-latency, peer-to-peer wireless protocol supported by ESP32 microcontrollers. The system uses distributed sensor nodes (Ambient light) mounted on street poles to detect time and ambient luminance. Nodes communicate locally using ESP-NOW to coordinate switching and dimming of lights, while a gateway node aggregates status and relays logs to a cloud server over Wi-Fi for monitoring and analytics. The design reduces energy consumption by dimming lights during low-activity periods and turning them to full brightness on demand, improves response time compared to cloud-dependent systems, and keeps costs low by using off-the-shelf ESP32 hardware.

Objectives

•Design a low-cost, low-latency public lighting control system using ESP32 devices and ESP-NOW.

•Implement local, autonomous decision-making at each pole (ambient light based).

•Achieve at least 50% energy savings relative to always-on lighting through dimming and on-demand brightening.

•Enable a gateway for remote monitoring, logging, and OTA updates.

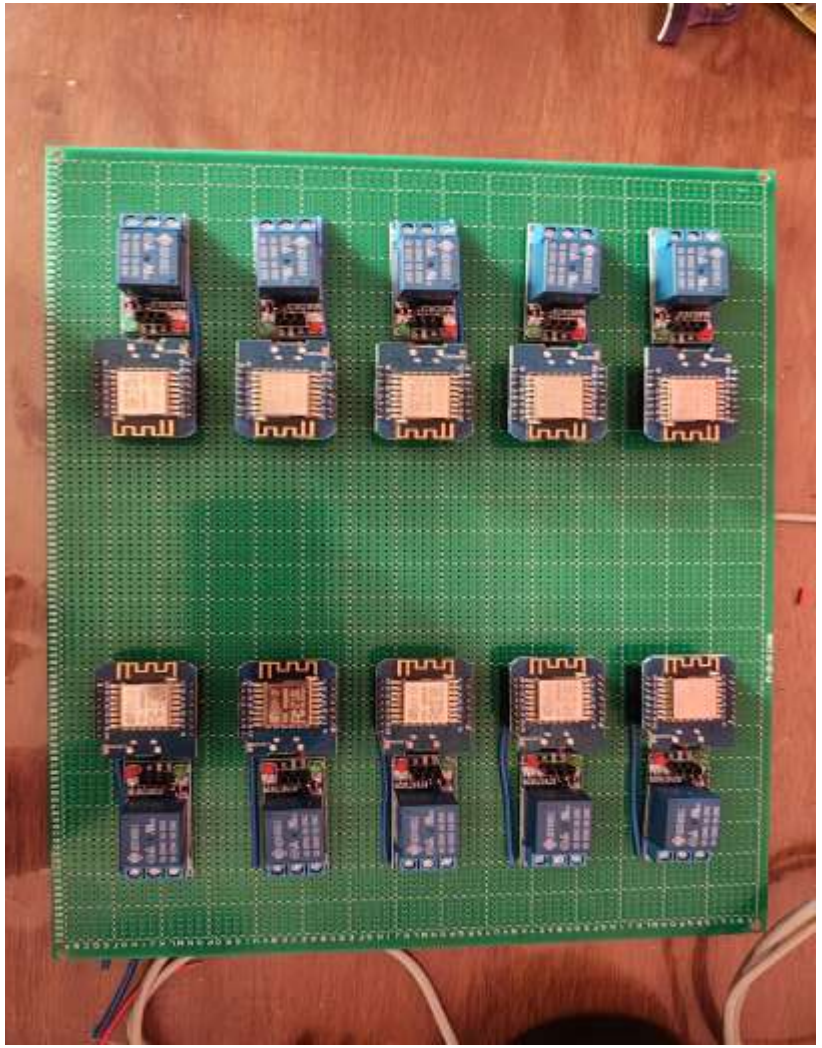
•Ensure reliability and safety (fail-safe: lights default to safe brightness on communication failure).

•Demonstrate scalability across multiple poles with robust inter-node coordination.

Challenges

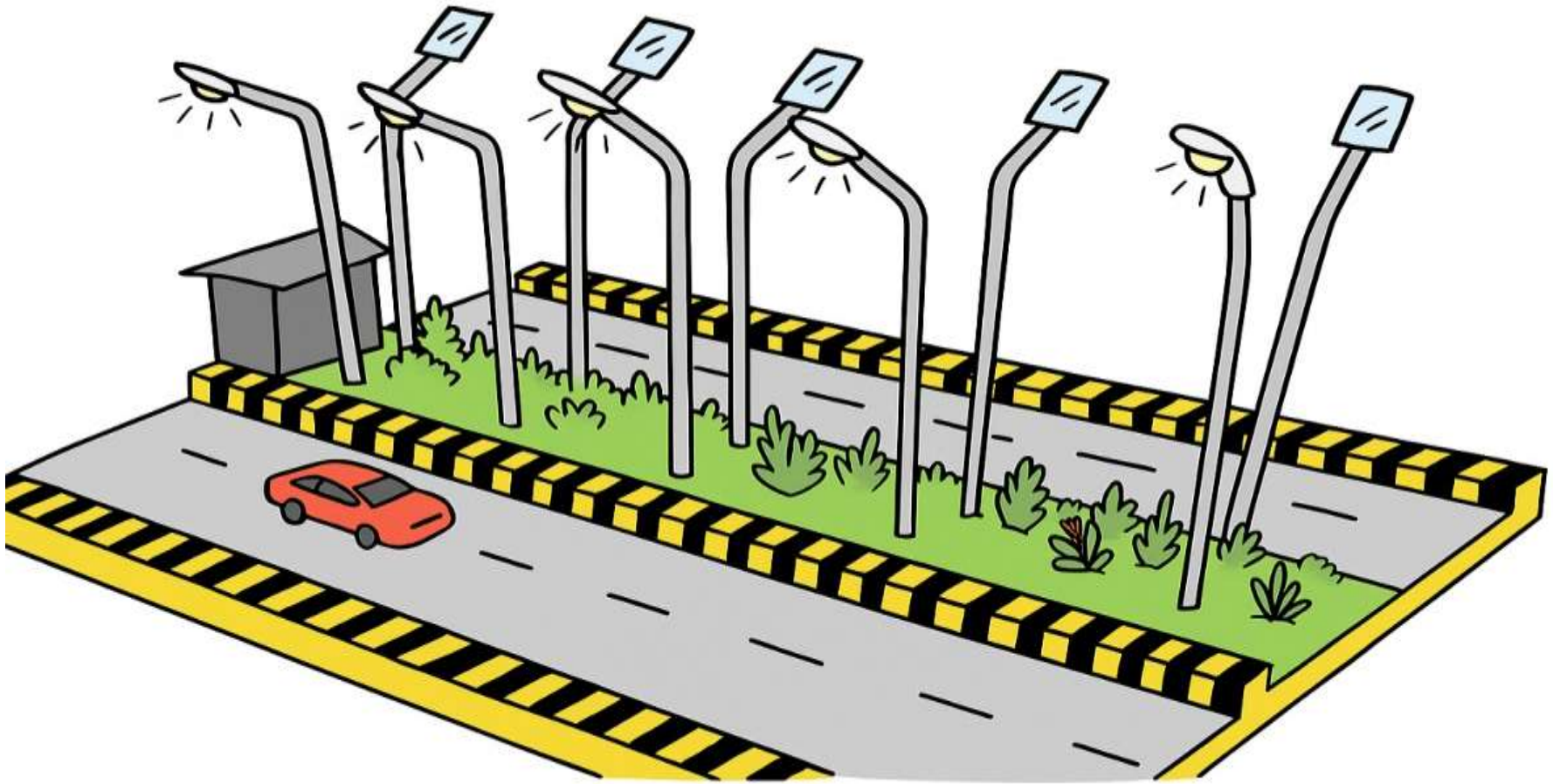
- Accurate synchronization of RTC with the microcontroller
- Relay circuit integration with high-voltage streetlight wiring
- Handling power fluctuations during operation
- Ensuring weatherproofing and protection from dust/moisture
- Maintaining long-term reliability in outdoor conditions
- Multiple trials needed for correct time calibration and scheduling

Project Progression



Project Progression

Architecture Diagram



Hardware & Software Requirements

Software Requirements

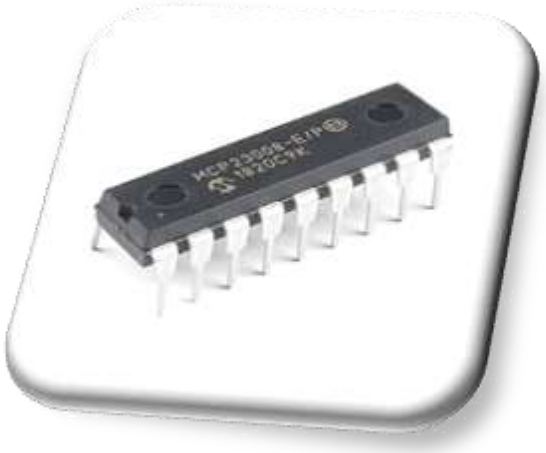
- IDE: Arduino IDE
- Libraries: ESP8266WiFi, ESP-NOW.
- Protocol: ESP-NOW (for peer-to-peer communication)

Hardware Requirements

Item	Specification
Microcontrollers	ESP8266 (D1mini) ×6 units
Sensors	Ambient Light Sensor ×1
Actuators	5V Single-Channel Relay Modules ×6
Lights	LEDs (for simulation)
Power	5V Power Supply

Components

5V Active Low Relay



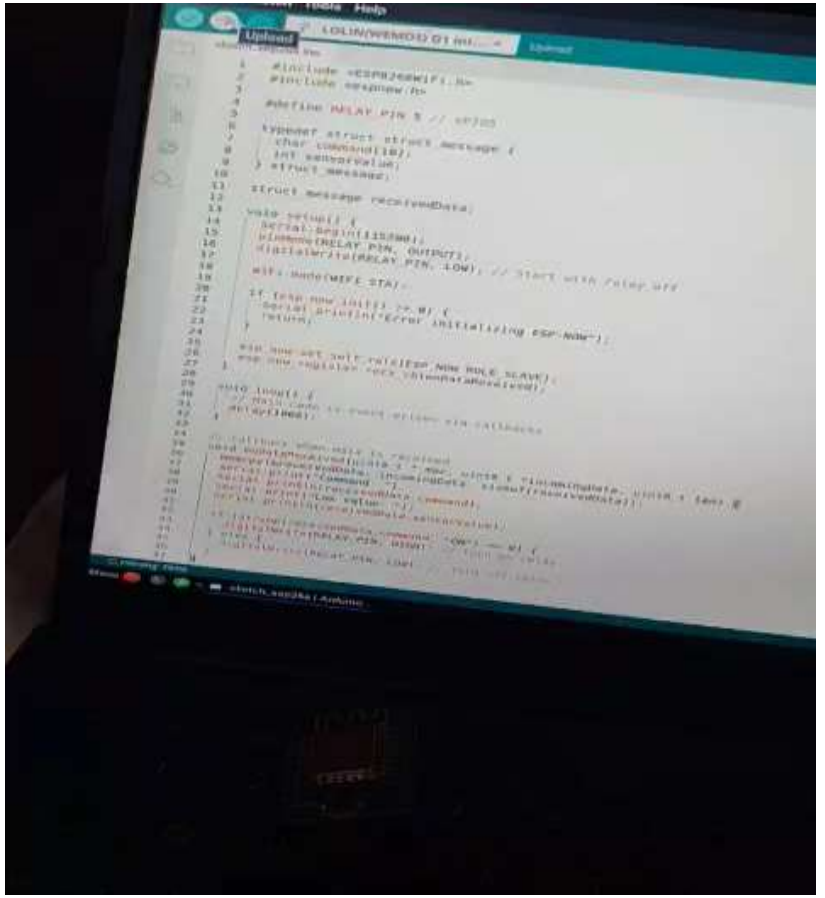
I2C [Inter-Integrated circuit]

Ambient Light Sensor

D1mini NodeMcu

Programming Video

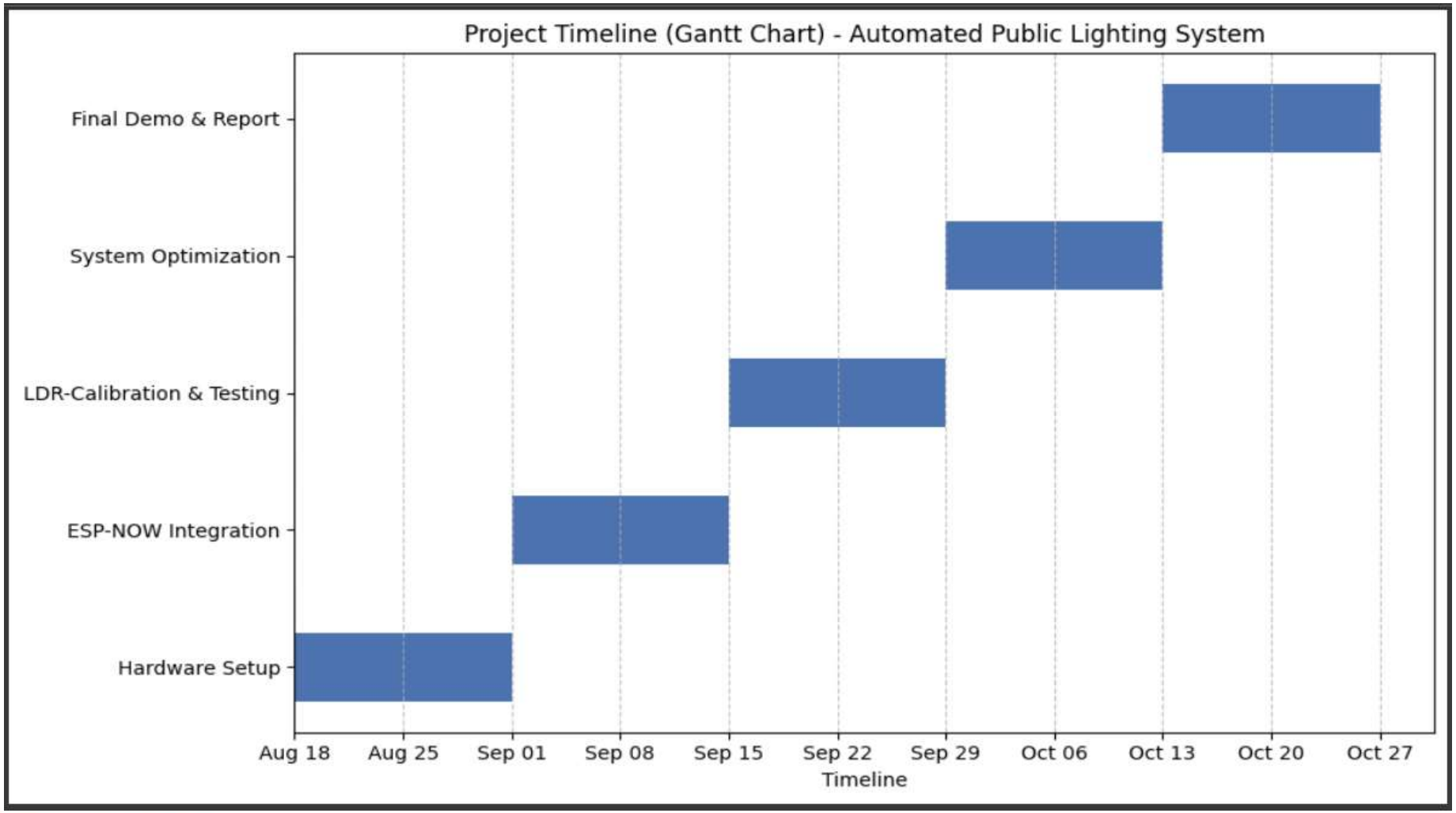
- Microcontroller Programming



GitHub Link

https://github.com/Amreen-552/Automated-Public-Lighting-System-Capstone-2025-

Timeline (Gantt Chart)



References

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2. Espressif Systems, “ESP-NOW Protocol Documentation,” 2023. [Online]. Available: https://docs.espressif.com/projects/esp-idf/en/latest/esp32/api-reference/network/esp_now.html

3. A. Gupta, “Low-Cost Automation Using ESP8266,” Journal of Embedded Systems, vol. 7, no. 4, pp. 45–59, Dec. 2022.

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