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IoT-Based Substation Monitoring System

Abstract:

The advancement of the Internet of Things (IoT) has revolutionized traditional power infrastructure by enabling intelligent, real-time monitoring and control. This project presents the design and implementation of an **IoT-Based Substation Monitoring System** using the **ESP32 microcontroller** to ensure improved safety, operational efficiency, and fault detection in power distribution substations. The system continuously monitors critical parameters such as **temperature and humidity** using the **DHT11 sensor**, **gas leakage or smoke** using the **MQ2 sensor**, and **current flow** using a **current sensor**. A **16x2 LCD display** provides local, real-time status updates, while **two relays control two separate power lines** (Line 1 and Line 2), each connected to an individual light bulb to simulate substation loads. Safety indicators such as **red and green LEDs** and a **buzzer** alert users in case of abnormal conditions like gas leakage, over-temperature, or excessive current flow. The ESP32 acts as the central controller and Wi-Fi gateway, transmitting sensor data and system status to the **Blynk IoT platform**, allowing remote users to monitor and control the substation environment via a smartphone app. The mobile interface also allows manual switching of relays and real-time alert notifications, ensuring proactive fault management. This system enhances the reliability and safety of electrical substations by offering a cost-effective, remotely accessible, and scalable monitoring solution suitable for rural and urban electrical distribution environments.

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