SLASH MARK IT Solutions

MAJOR PROJECT REPORT

LED Sensor Display System Using NodeMCU

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Abstract

The LED Sensor Display is an IoT-based embedded system designed to monitor environmental conditions using a sensor (such as a soil moisture sensor or DHT11) and display real-time data on an LED or OLED screen using an ESP8266 NodeMCU. This project highlights low-cost, low-power, and easy-to-deploy monitoring systems, particularly suited for agriculture and environmental applications.

The sensor collects analog or digital signals, which are processed by the ESP8266 microcontroller. The processed information is displayed locally on a screen, making it possible to visualize parameters such as soil moisture or ambient temperature and humidity without relying on a cloud platform. The project is scalable and can be extended to connect with online IoT dashboards.

Objective

The main objective of this project is to design and implement a real-time sensor-based display system using NodeMCU ESP8266. The system should be capable of:

[left=0.5cm]Reading real-time data from environmental sensors. Displaying sensor values on a local LED or OLED screen. Operating independently without constant internet connectivity. Serving as a prototype for smart agriculture or indoor monitoring systems.

Tools Used

[left=0.5cm]**Hardware:**

- - ESP8266 NodeMCU (Microcontroller with Wi-Fi)
  - Soil Moisture Sensor / DHT11 Sensor
  - OLED Display (SSD1306) / LED Display
  - Breadboard, jumper wires, USB cable
- **Software:**
  - Arduino IDE
  - ESP8266 Board Package
  - Libraries: `Adafruit_GFX`, `Adafruit_SSD1306`, `DHT`
  - Git and GitHub for version control

Introduction

With the advancement of IoT and embedded systems, real-time data collection and display have become increasingly relevant across various domains such as agriculture, smart homes, and environmental monitoring. In many cases, a simple and low-cost visual feedback system is essential for quick understanding and decision-making.

This project, titled **LED Sensor Display**, is developed using the ESP8266 NodeMCU, a low-cost microcontroller with built-in Wi-Fi. The main aim is to capture sensor readings from environmental inputs—such as soil moisture or temperature—and display them directly onto an LED or OLED display. Such a system is highly beneficial in areas lacking continuous internet connectivity or where data needs to be instantly readable on-site.

The modularity of the system allows integration with other sensors or cloud platforms for future expansion. The display component ensures that users can monitor sensor values in real-time without needing a mobile app or PC interface.

Literature Survey

Several existing solutions in the IoT ecosystem demonstrate how embedded systems can be used for sensor monitoring. Projects like smart irrigation systems or greenhouse monitors typically use sensors and connect them to microcontrollers for real-time feedback. Some approaches rely on cloud-based dashboards like Blynk or Thingspeak, which may not be feasible for offline environments.

In contrast, this project focuses on direct and minimalistic visualization. By using an OLED or LED display, this system cuts down latency and dependency on external networks. Academic papers and open-source platforms indicate that ESP8266 microcontrollers are preferred in DIY IoT due to their compactness, power efficiency, and ease of use with the Arduino IDE.

Furthermore, literature suggests that systems incorporating immediate visual feedback improve usability and user engagement, especially in rural or non-technical settings. Thus, the proposed system combines real-time sensing with simple display hardware to provide a more tangible and practical output.

Implementation Details

Hardware Setup

The core hardware components used in this project include:

- **ESP8266 NodeMCU:** Acts as the main microcontroller. It reads sensor values and drives the display.
- **Sensor Module:** A soil moisture sensor or a DHT11 temperature-humidity sensor is connected to the analog/digital input pin of the NodeMCU.
- **Display Unit:** An OLED display (SSD1306) is connected via I2C protocol to show sensor readings.

- **Power Source:** The system is powered via USB or external 5V source.

Circuit Connections

The sensor's output pin is connected to the analog or digital pin of the ESP8266, depending on the type of sensor. The OLED display is connected to the I2C pins: SDA to D2 (GPIO4), and SCL to D1 (GPIO5). A breadboard is used to make temporary connections during development.

Software Setup

The software is written using the Arduino IDE. Required libraries such as `Adafruit_GFX`, `Adafruit_SSD1306`, and `DHT` (if using temperature/humidity sensor) are imported. The program reads sensor values, processes the data, and updates the OLED screen every few seconds.

Working Principle

Once powered, the ESP8266 initializes the sensor and display. It reads analog/digital values from the sensor at fixed intervals and converts it into human-readable data (e.g., moisture percentage or temperature in Celsius). This information is then printed on the OLED screen using display functions provided by the graphics library.

Results

The LED Sensor Display system was successfully implemented and tested in a controlled environment. The OLED display clearly showed real-time sensor readings, and the ESP8266 NodeMCU reliably processed and updated values every 2 seconds.

Observed Output

- For a soil moisture sensor: the display showed values in the range of 0–100% based on dryness or wetness of the soil.
- For a DHT11 sensor: temperature and humidity values were displayed in degrees Celsius and %RH, respectively.

Figure 1: OLED displaying "Moisture: 78%" during test phase.

Figure 2: Wiring diagram on breadboard with NodeMCU and SSD1306 display.

The system consumed very low power and showed high responsiveness. The output was consistent across multiple test cases, and the refresh rate was optimal for real-time use.

Conclusion

The LED Sensor Display project demonstrates a compact and effective way to monitor environmental parameters without relying on external interfaces like smartphones or cloud dashboards. By leveraging the power of ESP8266 and an OLED display, this system enables real-time local feedback.

The modular design allows for easy substitution of sensors or upgrade to Wi-Fi-based alerts. Future improvements could include data logging, threshold-based alerts (buzzer/LED), or integration with cloud platforms.

This implementation is especially useful in remote or rural areas, greenhouses, and other scenarios where a quick glance at the display is more practical than complex interfaces.

Bibliography

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