REAL TIME WEATHER MONITORING SYSTEM USING SENSOR AND IOT TECHNOLOGY

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Abstract: This project presents a Real-Time Weather Monitoring System utilizing sensor technology and IoT for continuous environmental data acquisition and remote monitoring. The system is built around the ESP8266 Node MCU microcontroller, which facilitates wireless data transmission to the cloud for real-time access. Key environmental parameters such as temperature and humidity are measured using the DHT11 sensor, while air quality is assessed through a combination of gas sensors: MQ-2 (smoke and combustible gases), MQ-3 (alcohol vapours), and MQ-135 (CO_2 and other air pollutants). The system also features a 16x2 LCD display for local data visualization and a buzzer that serves as an alert mechanism when pollutant levels exceed predefined thresholds. Powered by a 12V battery, the setup ensures portability and uninterrupted operation. The L298 Motor Driver, though traditionally used for motor control, is incorporated here to demonstrate potential future enhancements such as automated ventilation or mobility. This IoT-based system offers a cost-effective, scalable solution for real-time environmental monitoring, crucial for smart cities, agricultural applications, and pollution control initiatives.

Key Words: IoT, Node MCU, L298 Motor Driver, DHT11 Sensor, MQ Gas Sensors

1. Introduction:

In recent years, the integration of sensor technology with the Internet of Things (IoT) has revolutionized the way environmental data is collected, monitored, and analysed. Real-time weather monitoring has become increasingly important in various sectors such as agriculture, urban planning, environmental protection, and disaster management. Traditional weather monitoring systems often lack portability, require significant infrastructure, and are limited by accessibility issues. To overcome these limitations, this project proposes a compact, cost-effective, and efficient real-time weather monitoring system using a combination of sensors and IoT components.

At the core of the system is the ESP8266 Node MCU, a Wi-Fi-enabled microcontroller that allows seamless data transmission to cloud platforms for real-time access from remote locations. Environmental parameters such as temperature and humidity are detected using the DHT11 sensor, while air quality is monitored through MQ-series gas sensors: MQ-2 for smoke and combustible gases, MQ-3 for alcohol vapours, and MQ-135 for carbon dioxide and other harmful gases.

A 16x2 LCD display is used to provide immediate on-site feedback, displaying live sensor data, while a buzzer is implemented to trigger alerts when abnormal conditions are detected, such as high levels of pollutants. The system is powered by a 12V battery, ensuring portability and continuous operation even in remote areas. The inclusion of an L298 Motor Driver opens possibilities for future automation features, such as rotating sensor modules or operating external actuators like fans or vents based on environmental conditions.

2. Literature Survey:

The integration of IoT with environmental monitoring has become a growing area of interest, offering innovative and scalable solutions for real-time data collection and analysis. Various studies and projects have been carried out using sensors and microcontrollers to monitor weather conditions and air quality. The following survey outlines existing research and technological implementations relevant to this project:

IoT-Based Weather Monitoring Systems**:** Several projects have been developed using IoT platforms like the ESP8266 Node MCU to transmit environmental data over the internet. These systems typically involve sensors such as DHT11 or DHT22 for temperature and humidity and upload data to cloud services like Thing-Speak or Blynk. Research shows that Node MCU offers a cost-effective, Wi-Fi-enabled solution for real-time data logging and remote monitoring.

Air Quality Monitoring using Gas Sensors: Previous studies have highlighted the importance of sensors like MQ-2, MQ-3, and MQ-135 for detecting harmful gases such as smoke, alcohol vapours, carbon monoxide, and ammonia. A project by Sharma et al. (2019) implemented a pollution monitoring system using MQ-series sensors and concluded that these low-cost sensors offer reasonable accuracy for non-industrial applications.

Use of LCD Displays and Buzzers for Alerts: Real-time systems often include visual and auditory feedback mechanisms. The 16x2 LCD display has been widely adopted for on-site display of sensor readings, while buzzers have proven effective in alerting users to abnormal conditions such as elevated pollutant levels or extreme temperatures.

Power Supply Considerations: Many weather monitoring systems are designed for portability and off-grid usage. Research supports the use of rechargeable 12V batteries to ensure uninterrupted power supply, especially in remote or outdoor environments.

Incorporation of L298 Motor Driver: While traditionally used in robotics for DC motor control, the L298 motor driver can be employed in weather systems for actuating components like exhaust fans, solar trackers, or mobile platforms. Some experimental models have shown its utility in automating environmental responses such as air purification or ventilation.

Comprehensive IoT Architectures: A comparative study by Patel et al. (2020) reviewed multiple IoT-based environmental monitoring systems and emphasized the importance of modular design. Their findings encourage the inclusion of expandable components like motor drivers and additional sensors for future upgrades.

The literature supports the feasibility and effectiveness of using sensor-based IoT systems for real-time weather and air quality monitoring. By integrating widely studied components like the ESP8266, MQ-series sensors, and DHT11, along with peripheral modules such as LCD displays, buzzers, and motor drivers, the proposed system aligns with current research trends while offering flexibility for future enhancements.

3. Methodology: The proposed system is a real-time weather and air quality monitoring device that integrates multiple sensors with IoT technology to measure, display, and transmit environmental data. It is designed to overcome the limitations of existing systems by offering a compact, cost-effective, and portable solution with real-time alert and remote monitoring capabilities. The system uses the ESP8266 Node MCU as the central microcontroller, enabling Wi-Fi connectivity for data transmission to cloud platforms or mobile applications. The DHT11 sensor monitors temperature and humidity, while air quality is assessed using MQ-2, MQ-3, and MQ-135 gas sensors, which detect smoke, alcohol, CO_2, and other harmful gases.

Real-time sensor data is displayed on a 16x2 LCD display for local viewing. A buzzer is incorporated to alert users instantly when gas concentrations exceed safe levels, helping prevent health hazards. The system is powered by a 12V battery, enhancing its portability and making it suitable for outdoor or remote installations. In addition, the inclusion of an L298 motor driver offers the potential for automation features, such as activating fans, opening vents, or moving sensor arrays, based on environmental conditions. This makes the system not only a monitoring tool but also an interactive and expandable platform for smart environment control.

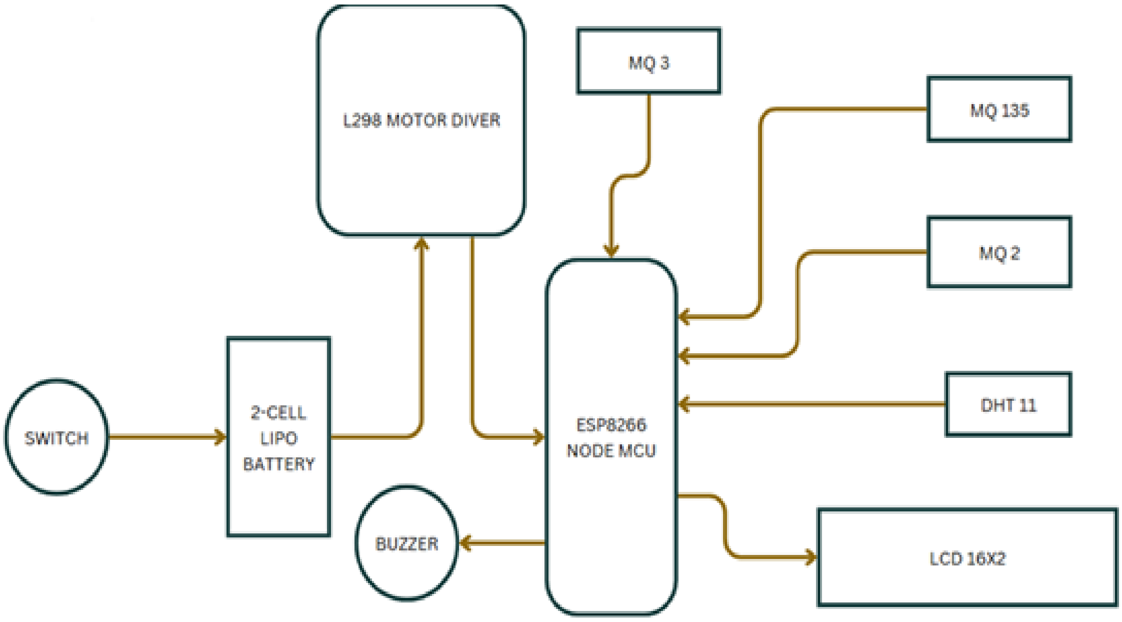

Figure: 1 Block Diagram

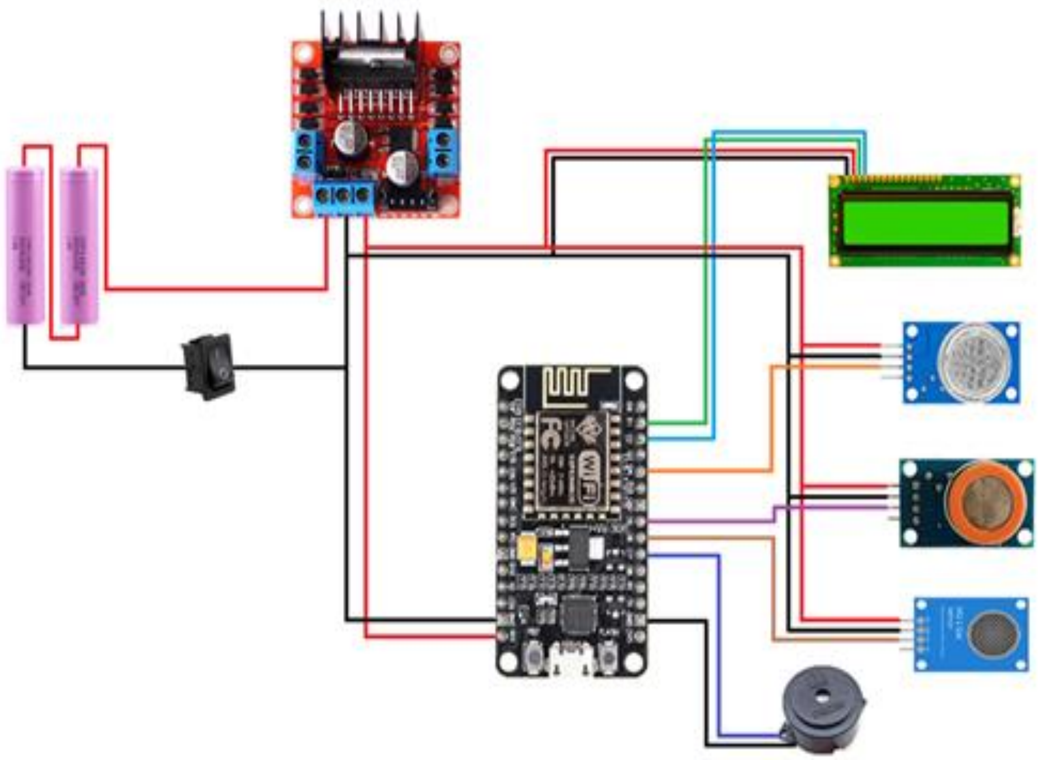

Figure: 2 Circuit diagram

4. Hardware Implementation:

a. **ESP8266 Node MCU (Microcontroller + Wi-Fi Module):**
    a. Acts as the central processing unit.
    b. Reads data from all connected sensors.
    c. Displays data on the 16x2 LCD.
    d. Sends sensor data to an IoT platform (e.g., Blynk, Things-peak) over Wi-Fi.

b. **16x2 LCD Display (with I2C):**
    a. Displays real-time readings such as temperature, humidity, and gas concentrations.
    b. Allows on-site monitoring without the need for a computer.

c. **DHT11 Sensor:**
    a. Measures temperature and humidity.
    b. Sends digital signals to the ESP8266.

d. **MQ-2 Sensor:**
    a. Detects smoke, LPG, and CO.
    b. Sends Analog output to the Node MCU for air quality monitoring.

e. **MQ-3 Sensor:**
    a. Primarily used for detecting alcohol and ethanol vapour.
    b. Helps monitor pollution and toxic vapour levels.

f. **MQ-135 Sensor:**
    a. Detects air quality, measuring levels of CO_2, NH_3, benzene, and other pollutants.
    b. Sends Analog signal to the microcontroller.

g. **Buzzer:**
    a. Used as an alert mechanism.
    b. Activated by the ESP8266 when gas levels exceed safe thresholds.

h. **L298 Motor Driver Module:**
    a. In this setup, likely used as a power distributor or for controlling future actuators (like fans or servo motors based on weather data).
    b. Takes 12V battery input and supplies power to other components safely.

i. **Power Supply (2x 18650 Batteries):**
    a. Supplies 12V power via the L298N.
    b. Power is distributed to the ESP8266, sensors, LCD, and buzzer.

j. **Power Switch:**
    a. Turns the entire system ON or OFF.

5. Software Used:

Arduino IDE:

The Arduino IDE (Integrated Development Environment) is a cross-platform software application designed for writing, compiling, and uploading code to Arduino microcontroller boards. It serves as the primary tool for developers, hobbyists, and students to create interactive electronics projects. With its intuitive interface and straightforward workflow, the Arduino IDE has become popular worldwide for prototyping and developing both simple and complex systems. The Arduino IDE stands out for its simplicity, flexibility, and extensive support network. It is ideal for beginners learning programming and electronics, as well as professionals developing advanced systems, making it a versatile tool in the world of embedded systems and IoT.

6. Results:

The Real-Time Weather Monitoring System using Sensor and IoT Technology was successfully designed, implemented, and tested. The system continuously monitored environmental parameters such as temperature, humidity, and air quality in real time using DHT11, MQ-2, MQ-3, and MQ-135 sensors. The integration with IoT allowed for remote access to data via the internet, providing users with live updates on environmental conditions.

1. 16x2 LCD displayed real-time data readings locally.
2. Buzzer successfully triggered when gas levels exceeded defined thresholds.
3. Wi-Fi Transmission (via ESP8266) allowed successful logging of sensor data to IoT platforms such as Blynk or Thing-Speak.
4. Real-time data refresh rate was observed to be < 2 seconds.
5. Alerts were instantly triggered on detecting dangerous gas levels.
6. The system operated efficiently on battery power for several hours, validating its portability and low power consumption.
7. All sensor readings were accurately reflected on the IoT dashboard for remote monitoring.

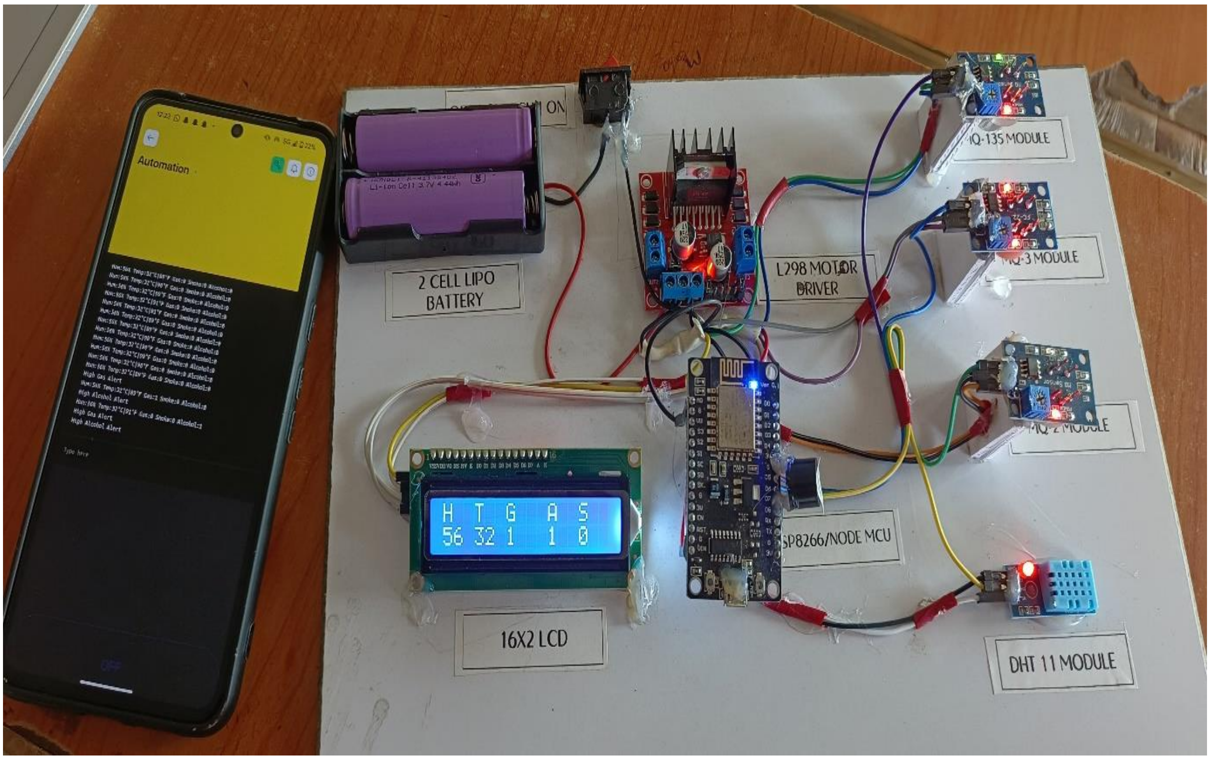

Figure: 3 final output

7. Advantages:

- Real-Time Monitoring: Provides live environmental data such as temperature, humidity, and air quality.
- Remote Accessibility via IoT: Users can monitor weather conditions from anywhere using a smartphone or computer.
- Low Power Consumption: Operates efficiently using a battery-powered system, ideal for remote areas.
- Cost-Effective: Uses affordable components like Node MCU, DHT11, and MQ sensors.
- User Alerts: Built-in buzzer alerts users instantly if harmful gas levels are detected.
- Scalable Design: Easy to add more sensors (e.g., rain, UV, wind) or connect to additional cloud services.
- Data Logging & Analysis: Capable of storing historical weather data for trend analysis and decision-making.
- Compact & Portable: Small form factor allows installation in homes, industries, and greenhouses.

8. Conclusion:

The Real-Time Weather Monitoring System using sensors and IoT technology has been successfully designed and implemented to monitor critical environmental parameters such as temperature, humidity, and air quality. By leveraging the capabilities of the ESP8266 Node MCU, along with sensors like DHT11, MQ-2, MQ-3, and MQ-135, the system provides accurate and timely data both locally (via LCD) and remotely through IoT platforms.

This project demonstrates how low-cost, open-source hardware combined with wireless communication can be used to build an efficient and scalable weather monitoring solution. The integration of a buzzer alert system ensures safety by notifying users when harmful gas levels are detected. The portability and battery-powered design further enhance its practical applications in real-world environments such as homes, industries, farms, and urban areas.

Overall, the system meets the objectives of real-time data collection, wireless transmission, and alert generation. It not only promotes environmental awareness but also serves as a foundation for future development in smart environmental monitoring and automation.

9. Future Scope

- Developing an Android/iOS app for more interactive real-time monitoring and notifications.
- Using machine learning to analyse collected data and forecast weather patterns.
- Incorporating solar panels to make the system self-sustainable and eco-friendly.
- Integration with SMS or email alerts to warn users of hazardous conditions.

- Creating a network of sensors across locations to monitor climate changes collectively.

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