WTP-1

Project Report
On
Air Quality Monitoring System using bot

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Abstract

The escalating concern over air pollution necessitates advanced systems for real-time monitoring and management. This report introduces an IoT-based Air Monitoring and Control Robot designed to autonomously assess environmental conditions and transmit data for analysis. Leveraging sensors like the MQ135 for air quality and the DHT11 for temperature and humidity, integrated with an ESP8266 microcontroller, the robot provides comprehensive air quality assessments. Its mobility, controlled via the Blynk IoT platform, allows for extensive area coverage, making it a versatile tool for applications ranging from industrial pollution monitoring to smart city implementations.

Introduction

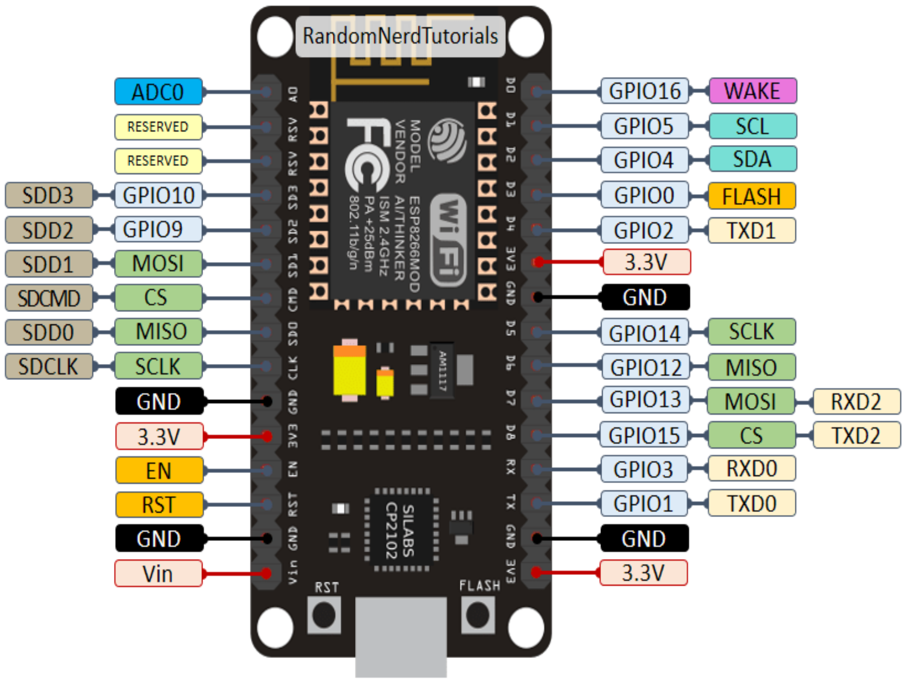
Air pollution poses significant threats to public health and the environment, leading to respiratory diseases and ecological degradation. Traditional stationary air quality monitoring systems often lack the flexibility to cover diverse areas effectively. To address this limitation, integrating Internet of Things (IoT) technology with robotics offers a dynamic solution. This report presents the development of an IoT-based Air Monitoring and Control Robot capable of real-time environmental monitoring and autonomous navigation, enhancing the scope and efficiency of air quality assessments.

Components:

- **Microcontroller:** ESP8266 (Wi-Fi-enabled for IoT integration)
- **Sensors:**
    - DHT11 for temperature and humidity measurement
    - MQ135 for air quality detection
- **Motor Driver & Motors:**
    - Two DC motors controlled by an L298N motor driver
- **Connectivity & Display:**
    - Blynk IoT app for data visualization and remote control

About the Components

- **ESP8266 Microcontroller:**
  The ESP8266 is a low-cost Wi-Fi microcontroller produced by Espressif Systems. It features a Tensilica L106 32-bit RISC processor operating at 80 MHz (with the capability to reach 160 MHz) and includes 32 KiB instruction RAM, 32 KiB instruction cache RAM, 80 KiB user-data RAM, and 16 KiB ETS system-data RAM. The chip supports IEEE 802.11 b/g/n Wi-Fi standards and offers various interfaces, including 17 GPIO pins, SPI, I²C (via software implementation), I²S with DMA, UART, and a 10-bit ADC. Its integrated TCP/IP protocol stack and minimal external circuitry requirements make it ideal for IoT applications.



- **DHT11 Sensor:**
  DHT11 is a basic, ultra-low-cost digital sensor that measures temperature and humidity. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and provides a digital signal on the data pin. The sensor operates with an operating voltage of 3.3V to 5V and has a measuring range of 20-90% RH humidity with an accuracy of ±5% RH, and 0-50°C temperature with an accuracy of ±2°C.

- **MQ135 Sensor:**
  The MQ135 is a semiconductor sensor used for detecting a wide range of gases, including ammonia (NH_3), nitrogen oxides (NO_x), alcohol, benzene, smoke, and carbon dioxide (CO_2). It operates at a voltage of 5V and provides an analog output proportional to the concentration of detected gases. The sensor has a detection range of 10 to 1000 ppm for various gases and features high sensitivity and a quick response time. It requires a preheating time of 20 seconds before accurate measurements can be taken.

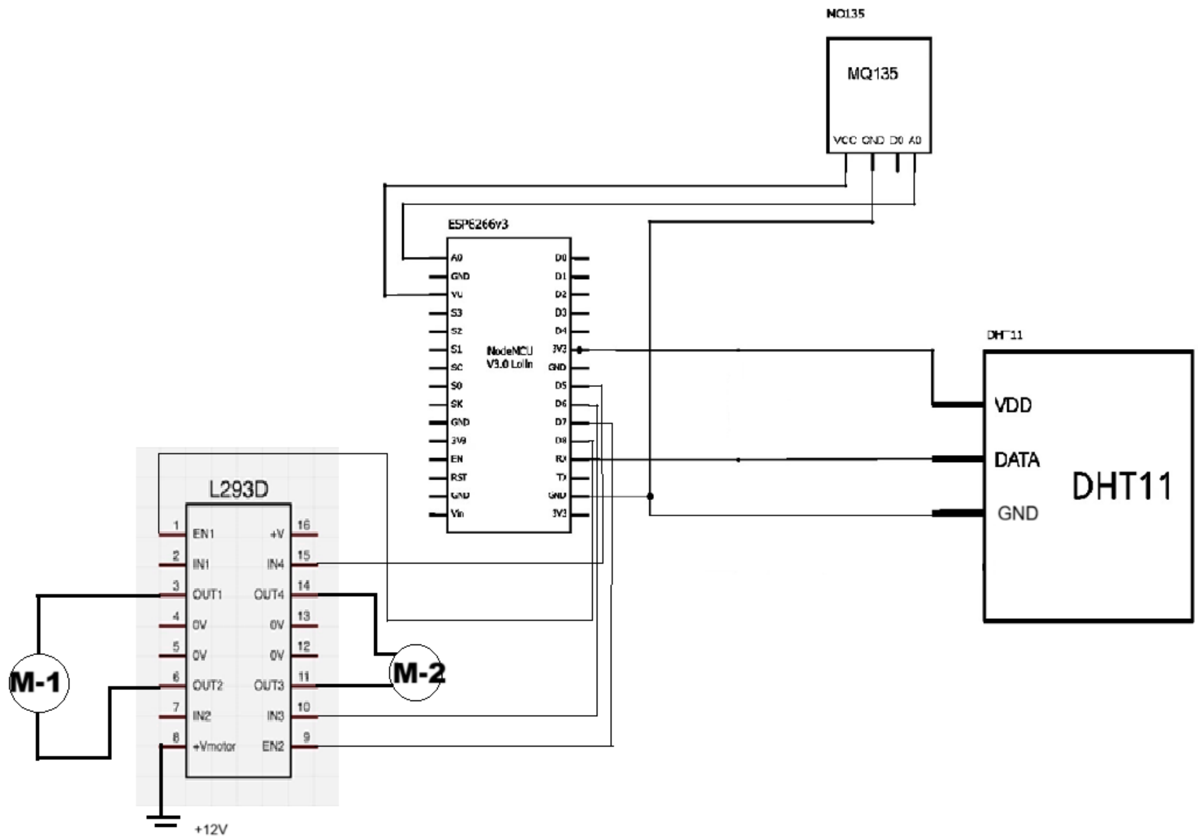
- **L298N Motor Driver:**

  L298N Motor Driver: The L298N is a dual H-bridge motor driver integrated circuit (IC) that allows for control of the direction and speed of two DC motors. It can handle motor supply voltages from 4.5V to 35V and peak currents up to 2A per channel. The module includes onboard 5V regulators, which can be used to power the logic circuitry.

  DC Motors: The robot utilizes two DC motors connected to the L298N motor driver to facilitate movement. These motors convert electrical energy into mechanical motion, allowing the robot to navigate its environment. The speed and direction of each motor are controlled by the signals sent from the ESP8266 through the motor driver.

- **Blynk IoT Platform:**
  Blynk is a versatile Internet of Things (IoT) platform that enables remote monitoring and control of connected devices through a user-friendly mobile application. In this project, Blynk is used to display real-time data from the DHT11 and MQ135 sensors, providing users with immediate insights into environmental conditions. Additionally, Blynk's virtual buttons allow users to remotely control the movement of the robot, sending commands that the ESP8266 interprets to operate the motors accordingly.

Circuit Diagram:



Working:

The IoT-based Air Monitoring and Control Robot operates through a series of interconnected processes, each contributing to its autonomous environmental monitoring and data transmission capabilities. Upon activation, the ESP8266 microcontroller initializes and establishes a connection to a pre-configured Wi-Fi network, enabling communication with the Blynk IoT platform. Simultaneously, the DHT11 and MQ135 sensors are activated to commence the collection of environmental data.

The DHT11 sensor measures ambient temperature and humidity by utilizing a thermistor and a capacitive humidity sensor, providing digital readings that are transmitted to the ESP8266 microcontroller. Concurrently, the MQ135 sensor detects concentrations of various gases, such as CO_2, ammonia, and benzene, by measuring changes in electrical resistance in the presence of these gases. These changes are converted into analog signals, which the microcontroller interprets to assess air quality levels.

The ESP8266 processes the collected sensor data, formatting it appropriately for transmission. Utilizing its Wi-Fi capabilities, it sends the data to the Blynk IoT platform, where it is displayed in real-time on the user's dashboard. Users can access this data remotely through the Blynk app, allowing continuous monitoring of environmental conditions.

The Blynk platform provides real-time visualization of the sensor data, presenting temperature, humidity, and air quality indices. Users can set predefined thresholds for these parameters; if the sensor readings exceed these limits, the system can trigger alerts, notifying users of potential environmental hazards.

Through the Blynk app, users can remotely control the robot's movements using virtual buttons corresponding to directional commands (forward, backward, left, right). When a command is issued, the ESP8266 interprets the input and signals the L298N motor driver to activate the appropriate motors, facilitating the desired movement. This mobility allows the robot to traverse different areas, collecting environmental data over a broader region.
In addition to real-time monitoring, the system periodically uploads sensor readings to cloud storage via the Blynk platform. This feature enables users to access historical data, facilitating long-term analysis of air quality trends and aiding in the development of strategies to mitigate pollution.

Users can remotely shut down or reset the system through the Blynk app. This functionality ensures that the robot can be safely powered down or prepared for a new monitoring cycle without the need for physical interaction, enhancing user convenience and system reliability.

Applications

1. Industrial Pollution Monitoring:
   Assessing air quality in and around industrial zones to ensure compliance with environmental standards.
2. Smart City Implementations:
   Integrating with urban infrastructure to monitor and manage air quality, contributing to healthier living environments.
3. Home or Office Air Quality Assessments:
   Providing insights into indoor air quality, enabling individuals and organizations to take corrective actions.

Conclusion

The IoT-based Air Monitoring and Control Robot effectively combines mobility with real-time environmental monitoring, offering a versatile solution to assess air quality across various settings. Its integration with the Blynk IoT platform facilitates user-friendly interaction and remote control, enhancing its practicality. Future enhancements could focus on improving sensor accuracy, incorporating autonomous navigation features, and expanding data analytics capabilities to provide more comprehensive air quality assessments.

References:

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