IOT BASED WIRELESS SENSOR NETWORK FOR AIR POLLITION MONITORING

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ABSTRACT

In view of the increasing levels of air pollution, an Advanced Air Quality Monitoring System has been developed using Arduino technology. The proposed system is capable of monitoring several critical air pollutants, including carbon dioxide, smoke, methane, sulfur dioxide (SO_2), hydrogen, ammonia (NH_3), and benzene. In addition, particulate matter (PM), which is a key indicator of air quality, is measured to provide an accurate real-time evaluation of pollution levels within a given area. The system employs gas sensors such as MQ-135, MQ-2, and MQ-7, which generate analog output signals. These signals are processed through Arduino-based programming, and the analyzed data is displayed on an LCD screen for easy interpretation. Designed for continuous real-time operation, the system provides a cost-effective and reliable solution for air quality assessment, particularly addressing the growing environmental challenges faced by urban regions in India.

INTRODUCTION

Air is a vital component of the biosphere, sustaining life across all ecosystems. However, rapid industrialization and urban expansion have led to a gradual decline in air quality. The increasing release of harmful emissions has altered the natural composition of the atmosphere, resulting in varying concentrations of gases such as nitrogen, carbon dioxide, carbon monoxide, and sulfur dioxide. These changes pose serious threats to the environment by disturbing ecological balance and adversely affecting the health of humans, animals, and plant life. In order to monitor and analyze these fluctuations in air quality and pollutant concentrations over time, the proposed project has been developed. With the continuous growth of industrial

activities and the emission of large amounts of toxic and non-native substances into the atmosphere, effective air quality monitoring has become increasingly essential.

LITERATURE SURVEY

Several research studies have explored Arduino-based platforms for real-time air quality monitoring because of their low cost, flexibility, and ease of deployment. Sharma et al. (2020) demonstrated the effective use of MQ-series gas sensors interfaced with Arduino to detect hazardous gases such as carbon monoxide, ammonia, and liquefied petroleum gas. Gupta and Singh (2019) presented an Arduino-based system integrated with GSM modules to enable remote transmission of air quality data. Similarly, Patil et al. (2021) utilized an Arduino Uno in combination with DHT11 and MQ-135 sensors to monitor environmental parameters including temperature, humidity, and air pollutant levels, achieving reliable localized measurements. Verma et al. (2020) investigated the integration of cloud-based IoT platforms for real-time data visualization and automated alert generation. The portability and low power consumption of Arduino systems make them suitable for deployment in both urban and rural environments, as reported by Iqbal and Khan (2018). Nevertheless, several studies have identified calibration and accuracy limitations associated with low-cost sensors, emphasizing the need for periodic calibration using reference-grade instruments. Additionally, Arduino systems combined with Wi-Fi modules such as the ESP8266 have been shown to provide efficient wireless data logging and easy access to online monitoring dashboards.

EXISTING SYSTEM

In one study, Graph Lab was utilized for monitoring air quality in indoor environments. Another approach applied the Internet of Things (IoT) framework using a Raspberry Pi 3B+ to monitor air pollution by measuring parameters such as particulate matter (PM), carbon monoxide (CO), carbon dioxide (CO_2), temperature, humidity, and atmospheric pressure. However, several critical pollutants, including nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3), were not considered, potentially resulting in incomplete or inaccurate air quality assessments, particularly in regions where these gases are prevalent. Some studies have explored the use of WebSocket technology with Raspberry Pi 3B+ for real-time pollution monitoring, but challenges related to data security and storage management were identified. Other research has demonstrated sensor interfacing with Raspberry Pi for

environmental monitoring; nevertheless, many existing systems lack comprehensive sensor integration to cover all major air pollutants. Furthermore, secure data transmission and efficient data storage are often neglected in these approaches. The integration of mobile or movable sensor units has been suggested as an effective solution to enhance the spatial accuracy and reliability of pollutant data collection.

PROPOSED SYSTEM

The sensors discussed earlier have been extensively employed in existing air quality monitoring systems. However, most of these models did not incorporate a dedicated ozone sensor along with other gas sensors to specifically measure ozone concentrations in a given region. In the proposed project, an ozone sensor has been integrated to improve the overall reliability and completeness of the monitoring system, as ozone measurement has become an increasingly important component of air pollution analysis. The system utilizes MQ-135, MQ-2, and MQ-7 sensors to effectively detect ozone as well as other harmful gases. This enhanced integration makes the proposed model more comprehensive and efficient than previously reported systems. Furthermore, the design is cost-effective, low in power consumption, compact in size, and capable of providing accurate measurements. As a

result, it serves as an improved solution for monitoring multiple environmental parameters and is well suited for deployment in both urban and rural environments.

BLOCK DIAGRAM
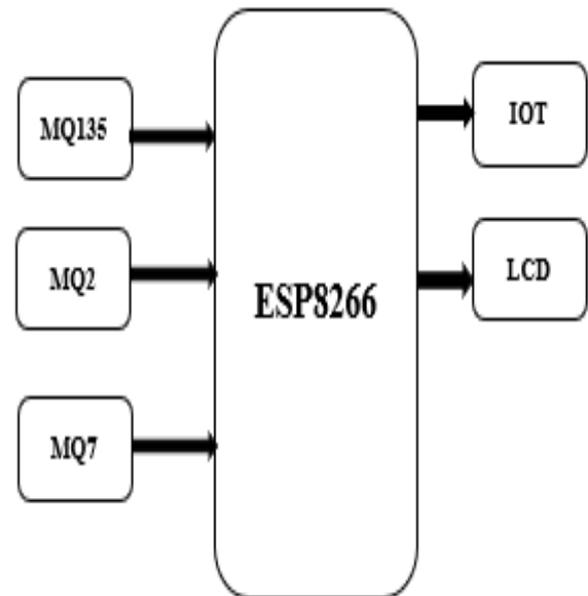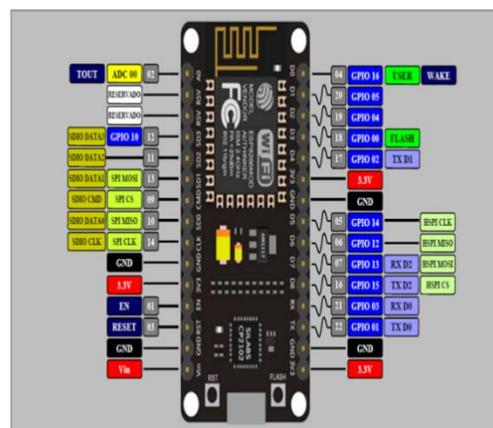

HARDWARE REQUIREMENT

Fig:1 ESP8266

The ESP8266 is a low-cost, low-power Wi-Fi microcontroller widely used in IoT applications. It integrates a full TCP/IP

stack, enabling direct internet connectivity without external modules. The controller supports 32-bit processing and operates at a clock speed of up to 80 MHz. ESP8266 can be programmed using Arduino IDE, NodeMCU, or MicroPython. It features multiple GPIO pins for interfacing sensors and peripherals. The module supports UART, SPI, and I²C communication protocols. Its compact size makes it suitable for embedded and portable applications. ESP8266 is commonly used for smart home and monitoring systems. It offers reliable wireless communication with minimal power consumption. Overall, the ESP8266 is an efficient and versatile platform for IoT development.

preheat time of around 20 seconds before delivering stable readings. Its sensing element, made of tin dioxide (SnO_2), changes resistance in response to varying gas concentrations, enabling accurate detection. The MQ-2 is widely used in applications such as home safety systems, industrial gas leak detectors, and vehicle monitoring systems. Its output signal increases with the concentration of detected gases, making real-time monitoring possible. Proper calibration is essential for maintaining accuracy and reliability. Compact, affordable, and easy to use, the MQ-2 is ideal for embedded systems and IoT-based air quality solutions.

Fig:3 MQ-7

Fig:2 MQ-2

The MQ-2 is a versatile gas sensor designed to detect flammable gases and smoke in the environment. It is highly sensitive to gases such as LPG, methane, alcohol, propane, hydrogen, carbon monoxide, and general smoke. Featuring both analog and digital outputs, it allows for flexible integration with microcontrollers like Arduino. Operating at 5V, the sensor requires a

The MQ-7 is a widely used carbon monoxide (CO) gas sensor designed for air quality monitoring applications. It can detect CO concentrations ranging from 20 to 2000 ppm, making it suitable for both safety and environmental systems. The sensor employs tin dioxide (SnO_2) as its sensitive material, which changes conductivity in the presence of CO gas. It offers both analog and digital outputs,

allowing easy integration with microcontrollers such as Arduino. The MQ-7 requires a 5V power supply and operates using a specific heating cycle that includes a high-temperature cleaning phase and a low-temperature sensing phase to ensure accurate detection. It is commonly used in CO leak detectors, indoor air quality systems, and smart home devices. The sensor is compact, cost-effective, and well-suited for real-time gas monitoring. For reliable performance, proper calibration and a warm-up period are essential. Its versatility and user-friendliness make it a popular choice in embedded and IoT-based air quality solutions.

Fig:4 MQ-135

The MQ-135 is a versatile air quality sensor capable of detecting a wide range of harmful gases such as ammonia, nitrogen oxides, alcohol, benzene, smoke, and carbon dioxide. It operates on a 5V power supply and offers both analog and digital outputs, making it easy to interface with microcontrollers like Arduino. The sensor uses a tin dioxide (SnO_2) sensing layer, which varies its resistance based on the concentration of gases in the air. It is widely used in environmental monitoring systems for homes, offices, and industrial settings. Due to its broad sensitivity, the MQ-135 is ideal for detecting indoor air pollutants. Accurate readings require proper calibration, often using clean air as a baseline. The module includes a built-in potentiometer to adjust the digital output sensitivity threshold. Its compact size, affordability, and user-friendly design make it a popular choice for real-time air quality applications. A preheating phase is necessary to ensure stable and accurate performance. Overall, the MQ-135 is a reliable and effective solution for monitoring air pollution.


Fig:5 LCD DISPLAY

An LCD (Liquid Crystal Display) is a widely used flat-panel display technology designed to show characters, numbers, or simple graphics. It works by controlling the passage of light through liquid crystals using electric signals. In embedded systems, popular LCD types include the 16x2 and 20x4 modules, which can display 16 or 20 characters per line across 2 or 4

lines, respectively. These modules are commonly interfaced with microcontrollers like Arduino, using either parallel or I2C communication protocols. Each character on the display is formed using a dot matrix arrangement of pixels. LCDs typically operate at 5V and include features like a backlight and contrast adjustment for clear visibility in different lighting conditions. They are frequently used in digital clocks, meters, control panels, and other embedded interfaces.

SOFTWARE REQUIREMENT

Arduino Software (IDE)
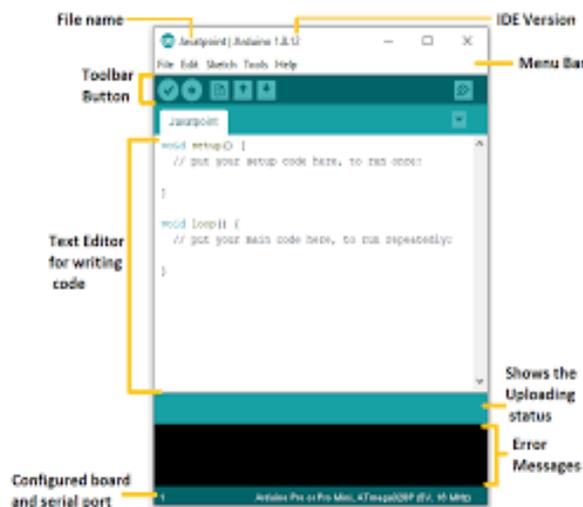
The Arduino IDE (Integrated Development Environment) is a simple yet powerful platform used to program Arduino boards. It supports C and C++ programming languages with an easy-to-understand syntax tailored for microcontroller applications. The IDE provides a clean and intuitive interface where users can write, compile, and upload code directly to Arduino hardware. It includes a rich set of built-in libraries, making it easy to perform common tasks such as reading sensors, controlling LEDs, or operating motors. The integrated Serial Monitor allows real-time communication and debugging between the Arduino and the computer. Compatible with Windows, macOS, and Linux, the IDE is accessible across multiple platforms. Users can extend its functionality using the built-in Library Manager, which offers access to numerous community-developed libraries. As an open-source tool, the Arduino IDE can be customized to fit specific development needs.

CONCLUSION

In the proposed system, an Arduino microcontroller is interfaced with multiple real-time sensors to continuously monitor environmental parameters. The sensor data is processed and analyzed by the microcontroller, and suitable actions are performed based on the evaluated readings.

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