# Desigining of air quality alert system

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***ABSTRACT***

*The objective of the project is to increase public awareness and understanding of air pollution, increase environmental monitoring, and ultimately contribute to better air quality management. The system can be applied in residential, industrial, and urban areas so that individuals will be alerted and protected from detrimental air pollutants that can cause harm and adverse effects to health and well-being.*

*An air quality alert system is necessary to inform the public when air pollution levels reach unhealthy levels, allowing people to take necessary precautions to protect their health, such as reducing outdoor activity, wearing masks, or staying indoors, by providing real-time information about air quality conditions in their area and potential health risks associated with them.*

*An Microcontroller based Air Quality Alert System is a state-of-the-art solution for real-time air quality monitoring and assessment, providing timely alerts to individuals and authorities about potential health hazards caused by air pollution.*

*Utilizing an Arduino sensor network (e.g., particulate matter (PM2.5, PM10), carbon dioxide (CO2), temperature, and humidity), the system continues to collect environmental data from various locations. This data is transmitted to a cloud platform, where it is processed and analyzed to determine the air quality index (AQI). If the AQI goes beyond safety thresholds, the system generates automated warnings, which are transmitted to users through a mobile app or SMS. The warning system can also supply advice to local authorities for real-time response, such as initiating pollution control measures or issuing health warnings.*

## 1. INTRODUCTION

An air pollution monitoring system is connected esp32 and air quality sensors to measure pollutants and present an alert message to users when the pollutants above the threshold value. The solution can be used to provide both indoor and outdoor air quality monitoring that provides real time information as well as possible warning of dangerous conditions**.**

The Air Pollution Monitoring System is a decent and affordable project for monitoring and alerting about the levels of air pollution in real time by using such sensors like the MQ135 to detect harmful substances like carbon dioxide (CO2), carbon monoxide(CO), and smoke. The sensor outputs this data to the ESP32 which then processes this data and can send out the alerts in the form of LED indicator, buzzer or LCD display.

Air pollution is a critical global concern, especially in urban areas where industrial emissions, vehicular exhaust, and other pollutants degrade the quality of the air we breathe. Poor air quality is linked to a range of health issues, including respiratory infections, heart disease, and even premature death. Monitoring air quality in real time can help individuals and communities take necessary precautions to protect their health.

To ensure seamless data transmission and real-time monitoring, the system utilizes the powerful ESP32 microcontroller as its core. Connected to sensors such as the DHT22 (for temperature and humidity), MQ7 (for carbon monoxide), MQ135 (for general air quality and $CO_2$), and a PM sensor (for particulate matter detection), the ESP32 collects environmental data continuously. This data is then transmitted wirelessly to a cloud-based or local server, where it can be accessed through user-friendly mobile applications through webserver . These server enable users to visualize live sensor readings, monitor historical trends, and receive immediate alerts when pollutant levels cross safe limits.

## 2-LITERATURE SURVEY

Jamal Mabrouki published a paper This study presents an Internet of Things (IoT)-based data logging system for real-time weather monitoring. Although not exclusively focused on air quality, the technologies and methodology presented are directly applicable and relevant to air quality monitoring systems using similar microcontroller platforms. The system employs sensors for environmental data acquisition, such as temperature, humidity, and atmospheric pressure.Data from the sensors is logged using Arduino Uno, processed, and transmitted via ESP8266 Wi-Fi module to a remote server.A web-based dashboard was developed for remote access and visualization of weather parameters.Data logging capabilities enable both real-time and historical data analysis. [1].

Mr. D. Tilak Raju discusses the project focuses specifically on designing an **Arduino-based air quality monitoring system**. It uses **gas sensors** to detect harmful gases and pollutants in the air, making it directly relevant to your proposed **air quality alert system**. Utilized MQ-135 gas sensor, which is sensitive to NH3, NOx, alcohol, benzene, smoke, and CO2. Arduino Uno processes the sensor input and sends data to a local display (LCD or Serial Monitor).Basic alert mechanism using LEDs or buzzers for threshold breaches (e.g., when pollution levels exceed safe limits). [2].

Anabi Hilary Kelechi Mohammed H, research expands upon earlier work by designing a more comprehensive, low-cost air quality monitoring system. It combines multiple gas sensors, Arduino-based processing, and wireless communication, aligning well with IoT standards.Used sensors such as MQ-135, DHT11 (for temperature and humidity), and ESP8266 for Wi-Fi.Data transmission to cloud platforms (like Thingspeak) for visualization and storage. Developed mobile and web applications for real-time monitoring and alert notifications. Implemented a threshold-based alert system using a buzzer and LED. [3].

## 3-REQUIREMENT ANALYSIS

HARDWARE COMPONENTS

An ESP32 can be used as the core microcontroller in an air quality alert system, connecting to various sensors to collect data, process it, and transmit it to a cloud platform for monitoring and alerting. This system can identify and quantify harmful gases and pollutants as well as measure temperature and humidity.

**• Sensor Data Acquisition:**

The ESP32 connects to sensors that measure different air quality parameters, including particulate matter (PM), CO2, humidity, temperature, and other pollutants.

**• Data Processing and Analysis:**

The ESP32 processes the sensor data, potentially applying algorithms to filter noise, calibrate readings, and calculate an air quality index (AQI) or other relevant metrics.

**• Connectivity and Communication:**

The ESP32 uses Wi-Fi or other wireless communication protocols to transmit the processed data to a cloud platform like ThingSpeak, Blynk, or other IoT platforms.

**• Alerting and Monitoring:**

The cloud platform can then store and display the air quality data, potentially triggering alerts to users based on predefined thresholds or rules.

**Benefits of using an ESP32:**

**Low Cost:**

ESP32 is a relatively inexpensive microcontroller, making it accessible for DIY and educational projects.

**Connectivity:**

It has built-in Wi-Fi and Bluetooth connectivity, facilitating communication with the cloud and other devices.

**Versatility:**

It can be programmed using various platforms like Arduino IDE, Espressif IoT Development Framework (IDF), and Micropython, offering flexibility in development.

**Power Efficiency:**

ESP32 can operate on low power, making it suitable for battery-powered applications.

**MQ -135(Gas Sensor)**

The MQ135 gas sensor is commonly used in air quality alert systems to detect various harmful gases like ammonia, sulfide, benzene, alcohol, and smoke. It's a semiconductor sensor that exhibits high sensitivity to these gases and can be used in a variety of applications, including domestic and industrial air pollution detection.

When integrated with a microcontroller like Arduino or ESP32, the MQ135 sensor can be used to create an alert system that notifies users when harmful gas levels exceed a certain threshold. The MQ135 sensor is particularly sensitive to ammonia, sulfide, and benzene, but it can also detect other harmful gases and smoke. When the gas concentration exceeds the threshold, the microcontroller triggers an alert, which can be displayed on an LCD screen, sent as SMS or used to activate other devices.

MQ135 Gas Sensor module for Air Quality having Digital as well as Analog output. Sensitive material of MQ135 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensors conductivity is more higher along with the gas concentration rising. MQ135 gas sensor has high sensitivity to Ammonia, Sulphide and Benze steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application. Used for family, Surrounding environment noxious gas detection device, Apply to ammonia, aromatics, sulfur, benzene vapor, and other harmful gases/smoke, gas detection, tested concentration range: 10 to 1000 ppm.

## SOFTWARE REQUIREMENTS

Software required for the system

### ARDUINO IDE

Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing and compiling the code. It is available for all operating systems.The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

**Embedded C Programming**

Embedded C programming is a specialized form of programming that is tailored for embedded systems, which are computer systems designed to perform specific tasks or functions within a larger system. In the context of a women's safety device with GPS tracking, embedded C programming plays a crucial role in enabling the device to function effectively and securely.

## 4.DESIGN

### Block Diagram

This block diagram illustrates an Air Quality Alert System centered around the ESP32 microcontroller. Various sensors are connected to the ESP32 to detect different environmental parameters:

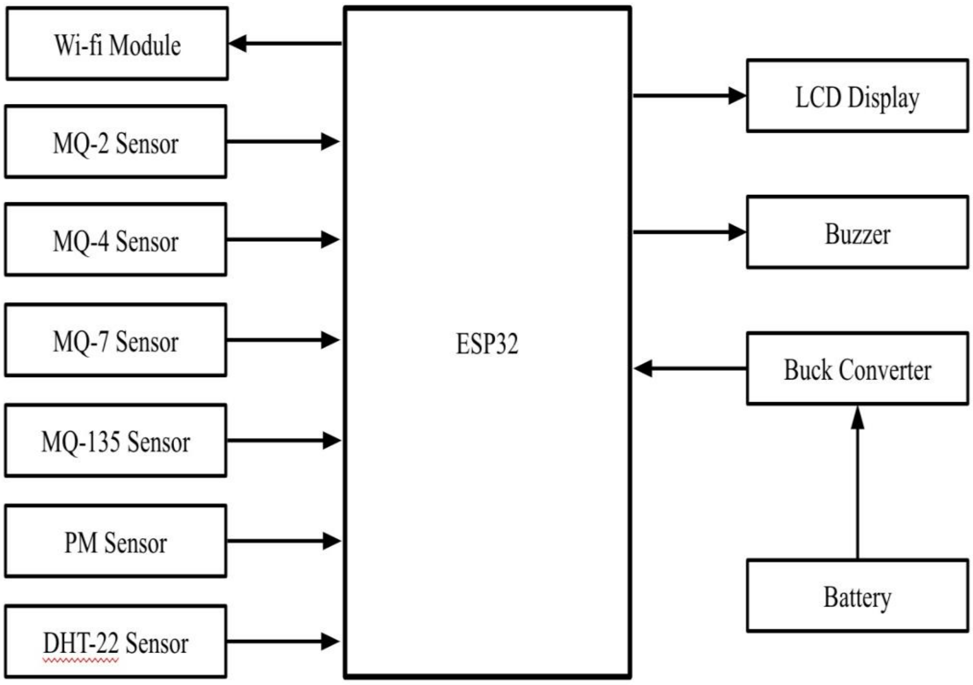

**Fig4.1.Block Diagram**

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MQ-2, MQ-4, MQ-7, and MQ-135 sensors detect harmful gases like carbon monoxide, carbon dioxide and other air pollutants.

- The PM sensor measures particulate matter, which are tiny particles in the air that affect respiratory health.
- The DHT-22 sensor provides temperature and humidity data, which are important for understanding air quality conditions.

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The ESP32 collects, processes, and analyzes the data from all these sensors. It then displays the results on an LCD display for users to view. If any of the pollutant levels cross a predefined threshold, a buzzer is activated to alert users of dangerous conditions. Power is supplied by a battery, which goes through a buck converter to regulate voltage suitable for the ESP32 and connected components. This system can be used for both indoor and outdoor environmental monitoring

**FLOW CHART**

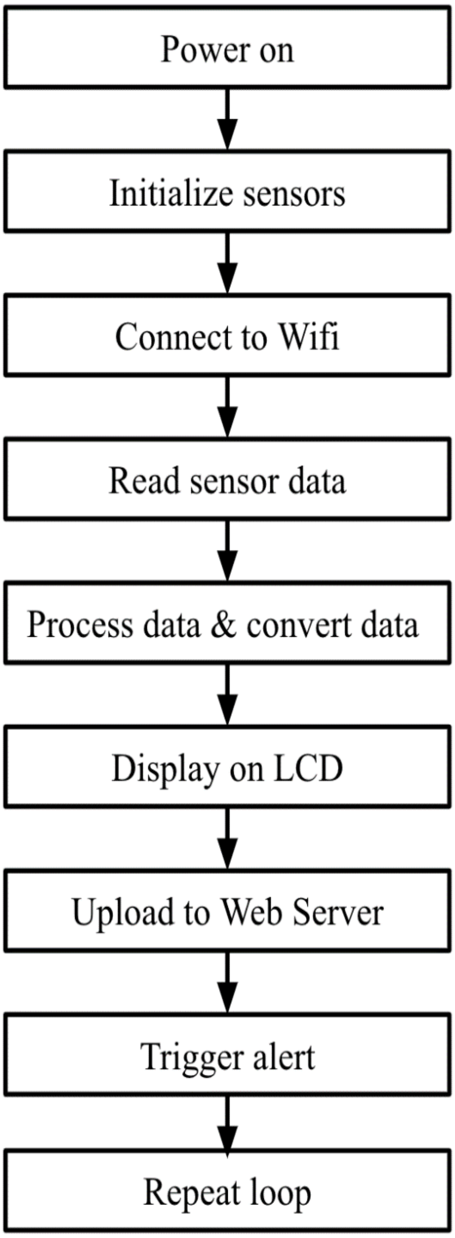


**Fig.4.2.Flow Chart**

## 5-RESULTS

### Case I : At Initial Condition

The figure shows the **testing of the air quality alert system at initial conditions**. The system is powered on and initialized, with all sensors connected and functioning. The LCD display shows the message **"Air Quality Init"**, indicating the system is beginning air quality detection. No hazardous gases or abnormal values are detected, so no alerts are triggered. This confirms the system is ready and functioning properly in a clean air environment.

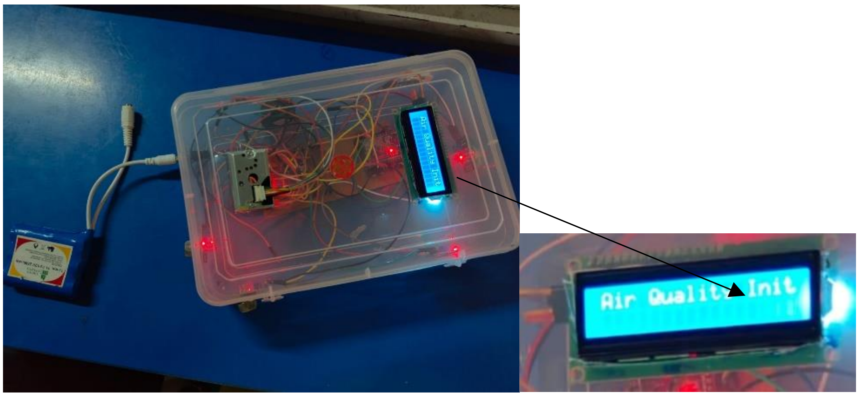


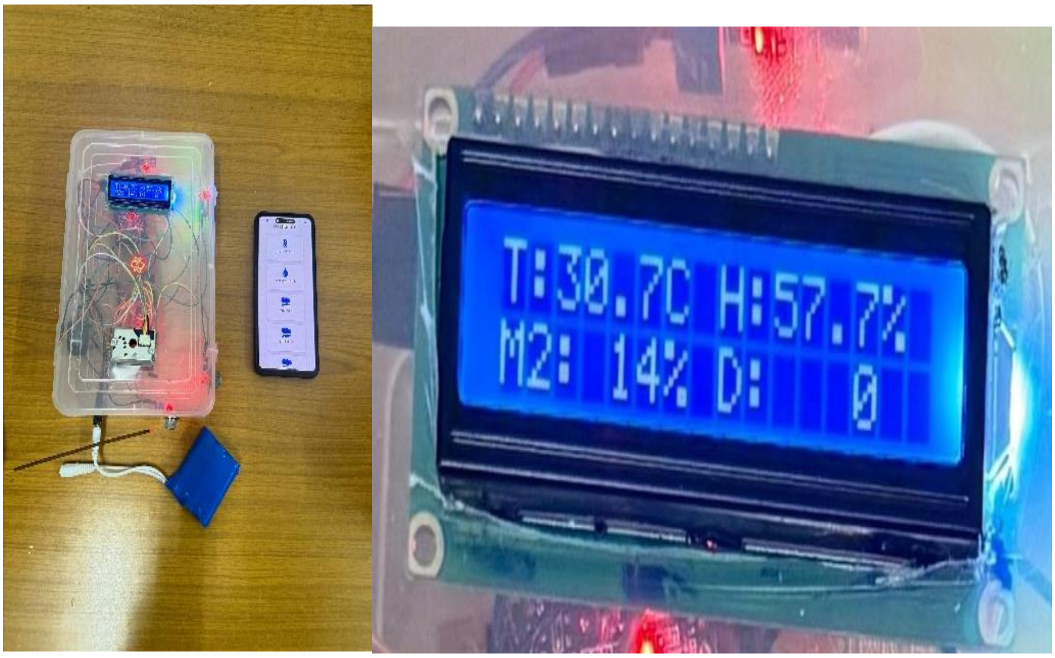
**Fig5.2.Case i**

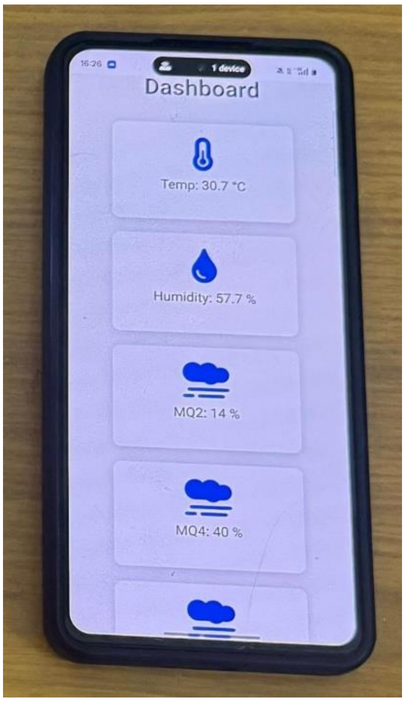
This system monitors air quality parameters such as CO2, PM2.5, or VOC levels.When pollution exceeds safe levels, it can alert users via LED or screen messages.

**Case II : When Gases Are Detected**

The image shows the air quality alert system actively monitoring environmental data. The LCD screen displays real-time values for temperature (30.7°C), humidity (57.7%), and gas levels like MQ2 and dust density. A mobile dashboard is visible next to the device, showing synced data via Wi-Fi, confirming successful cloud/server integration. The system is powered by a battery pack, making it portable. An incense stick is placed nearby to simulate gas emission and test the sensors' response.

It's essential to have logging and alert mechanisms in place, especially in environments where gas leaks could lead to fire or health hazards. Integrating such sensor systems with cloud platforms can also allow long-term data storage and pattern analysis. A reading of 15% may not require immediate action, but it’s a valuable early warning. It shows the system is actively protecting the environment or facility it monitors.





Dashboard

Temp: 30.7 °C

Humidity: 57.7 %

MQ2: 14 %

MQ4: 40 %

**Fig5.3.Case ii**

When the gas concentration is detected at 15% of the MQ2 sensor's range, it indicates that there are flammable or combustible gases present in the air, but not yet at a critical level. This level is still considered low and not immediately dangerous, though it may suggest poor ventilation or the beginning of a leak. Continuous monitoring is crucial in such scenarios to ensure the gas level does not rise further. The system likely has an alert or threshold mechanism, where higher levels would trigger warnings or even activate exhaust fans or shut-off systems.

## 6.CONCLUSION AND FUTURE SCOPE

### 6.1 Conclusion

The Air Quality Alert System is a smart, cost-effective solution for monitoring and managing environmental health.It uses the ESP32 microcontroller to collect data from multiple sensors including DHT22, MQ7, MQ135, and a particulate matter sensor.These sensors measure key air parameters such as temperature, humidity, carbon monoxide (CO), carbon dioxide ($CO_2$), and particulate matter (PM2.5/PM10).The ESP32 transmits this real-time sensor data wirelessly to a cloud server (through webserver ).The server acts as a bridge between the ESP32 and the mobile device, storing and serving the data for visualization.Mobile users access this data using webserver through Wi-Fi or mobile data provided by their mobile operator. The system allows users to set predefined thresholds for each pollutant and receive instant alerts when unsafe levels are detected.With live dashboards, historical graphs, and remote notifications, users can respond quickly to harmful air conditions.It is modular and scalable, suitable for deployment in homes, schools, industries, or public spaces.The system eliminates the need for expensive commercial air monitoring equipment.

It supports both cloud and offline (local MQTT) setups depending on the use case.Offline buffering ensures temporary data storage during internet outages, improving reliability.The use of apps from the Play Store ensures accessibility and convenience without needing custom code.Overall, the system improves air quality awareness, enables preventive health action, and promotes sustainable living.

**6.2 Future Scope**

The Air Quality Alert System can evolve into a smart environmental management platform.Future versions can integrate AI-based prediction models to forecast pollution trends and alert users in advance.It can be expanded to control devices like air purifiers, exhaust fans, or HVAC systems automatically based on sensor data.Integration with smart city infrastructure can help municipalities monitor and manage pollution hotspots.

Adding GPS modules will enable real-time geo-tagged air quality mapping across large areas.Data collected can support government policy-making and urban planning for cleaner

Mobile apps can offer health advice, especially for sensitive groups like children and asthma patients.

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