# Home Air Quality Monitoring System

*Abstract*— **The "Air Quality Monitoring System using NodeMCU ESP8266, MQ135 Air Quality Sensor, and DHT11 Sensor" is a comprehensive solution for real-time monitoring of air quality. The system uses a NodeMCU ESP8266 board, MQ135 air quality sensor, and DHT11 sensor to measure pollutant levels, temperature, and humidity. The system integrates hardware components, software programming, and cloud-based data storage and visualization. The NodeMCU ESP8266 board acquires, processes, and transmits data from the sensors to the Thingspeak cloud server, which is then displayed on a mobile app developed using MIT App Inventor. The app allows users to monitor air quality parameters remotely, providing accurate information for raising awareness and making informed decisions about maintaining a healthy living environment. Future improvements include integrating additional gas sensors, enhancing alert and notification methods, and incorporating automation actuators. The project showcases the successful implementation of an affordable and accessible air quality monitoring system, making it a valuable tool for individuals, communities, and organizations.**

*Keywords*— **NodeMCU ESP8266 , MQ-135 , DHT11 , Thingspeak , Air Quality , Temperature , Humidity.**

## I. INTRODUCTION

Air pollution is a global issue with severe health and environmental consequences, including respiratory diseases, cardiovascular problems, and premature deaths. Traditional methods of monitoring often involve expensive and stationary equipment, limiting their accessibility and coverage. This paper presents an air quality monitoring system that uses IoT technology to provide real-time monitoring of air pollutants, enabling timely interventions and informed decision-making to mitigate the adverse effects of poor air quality. The system integrates NodeMCU ESP8266 microcontrollers, MQ135 gas sensors, DHT11 temperature and humidity sensors, and wireless connectivity, providing a comprehensive solution for air quality monitoring.

Key air pollutants such as carbon monoxide (CO), nitrogen dioxide (NO2), and particulate matter (PM) are accurately measured and monitored using sensors that continuously collect data on pollutant concentrations, temperature, and humidity. The system incorporates calibration techniques and quality control measures to ensure data accuracy and reliability. Data preprocessing and analysis are performed to interpret sensor readings and generate meaningful insights.

The system offers several advantages over traditional approaches, including its low-cost and portable nature, allowing widespread deployment in various settings, and its seamless integration of IoT technology. The effectiveness of the system is evaluated through comprehensive field tests and comparisons with established monitoring methods, demonstrating its capability to provide real-time and reliable air quality data.

In conclusion, the proposed air quality monitoring system utilizing NodeMCU ESP8266, MQ135 gas sensor, and DHT11 temperature and humidity sensors offers an innovative and efficient approach to address air pollution challenges. By leveraging IoT technology, the system provides real-time monitoring, data analysis, and remote accessibility, empowering stakeholders to make informed decisions and take proactive measures to improve air quality.

### A.NodeMCU ESP8266

The NodeMCU ESP8266 is a versatile development board that combines the capabilities of a microcontroller and Wi-Fi connectivity. It plays a crucial role in the home air quality monitoring system, enabling IoT connectivity, sensor data acquisition, and data transmission to the ThingSpeak cloud server.

The NodeMCU ESP8266 board is built around the ESP8266 microcontroller, which features a single-core processor and integrated Wi-Fi capabilities. This compact and cost-effective board provides an ideal platform for connecting sensors and transmitting data over Wi-Fi.

In the context of the home air quality monitoring system, the NodeMCU ESP8266 board performs the following functions:

1. Sensor Data Acquisition: The NodeMCU ESP8266 is responsible for interfacing with the sensors used in the system, such as the MQ135 gas sensor and DHT11 temperature and humidity sensor. It reads the sensor values and converts them

into digital data that can be processed by the microcontroller.

2. IoT Connectivity: The NodeMCU ESP8266 connects the home air quality monitoring system to the internet via Wi-Fi. This allows the system to transmit the sensor data to a cloud server for storage and analysis. By establishing a connection to the ThingSpeak cloud server or any other IoT platform, the NodeMCU ESP8266 enables real-time monitoring and remote access to the air quality data.

3. Data Transmission to ThingSpeak: Once the sensor data is acquired, the NodeMCU ESP8266 facilitates the transmission of the data to the ThingSpeak cloud server. It establishes a secure connection with the server using the Wi-Fi network and sends the sensor readings, including air quality parameters like gas concentrations, temperature, and humidity, to the appropriate fields in the ThingSpeak channel.

4. Cloud Storage and Visualization: The ThingSpeak cloud server receives the sensor data sent by the NodeMCU ESP8266 and stores it in a structured manner. It provides features for data visualization, real-time monitoring, and historical analysis. Users can access the air quality data from anywhere using a web browser or mobile application, enabling them to track trends, identify patterns, and make informed decisions regarding indoor air quality.

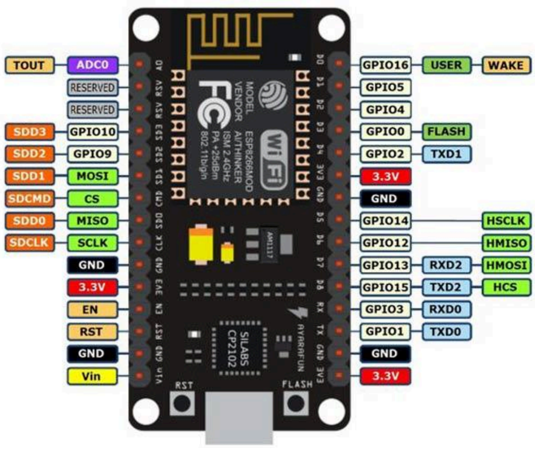


Fig. 1 : NodeMCU ESP8266 Board

Overall, the NodeMCU ESP8266 board acts as the central hub of the home air quality monitoring system, connecting the sensors to the internet and facilitating the transmission and storage of data on the ThingSpeak cloud server. It enables real-time monitoring, remote access, and data-driven decision-making to ensure a healthier and safer indoor environment enhancing its appeal for developers and makers in the IoT space.

## B.MQ135

The MQ135 gas sensor is a semiconductor gas sensor designed to detect various gases in the air, including ammonia (NH3), nitrogen oxides (NOx), benzene, smoke, and volatile organic compounds (VOCs). It operates based on chemiresistive changes in its semiconductor material when exposed to different gases. The sensor provides an analog output voltage that varies depending on the concentration of the detected gas. MQ135 sensors find applications in air quality monitoring, gas leakage detection, indoor air quality assessment, environmental monitoring, and IoT projects related to air pollution detection. Calibration and consideration of factors like temperature and humidity are important for accurate readings and reliable performance.

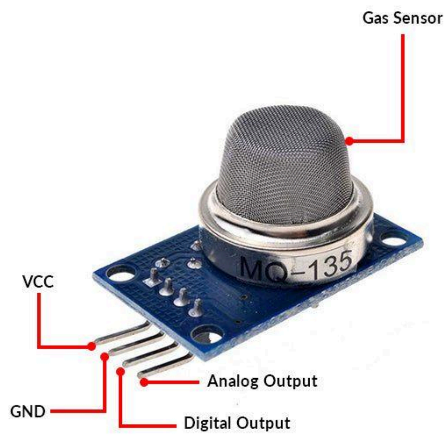


Fig. 2 : MQ-135 Sensor

The MQ135 gas sensor is a crucial component of the home air quality monitoring system project, specifically used for detecting and measuring various air pollutants. It plays a vital role in providing real-time data on the concentration of harmful gases present in the surrounding environment, enabling users to assess and improve indoor air quality.

The MQ135 sensor employs a tin dioxide (SnO2) sensing element that is highly sensitive to a wide range of gases, including carbon dioxide (CO2), ammonia (NH3), nitrogen oxides (NOx), alcohol, and various volatile organic compounds (VOCs). When these gases come into contact with the sensing element, they cause a change in its electrical conductivity. The sensor's internal circuitry measures this conductivity variation and converts it into an analog voltage signal, which is then read by the NodeMCU ESP8266 microcontroller.

In the context of the project, the MQ135 gas sensor is connected to the NodeMCU ESP8266 board, which serves as the central processing unit. The sensor communicates with the microcontroller using the analog input pins, allowing the system to monitor the concentration levels of different gases. By analyzing the sensor readings, the home air quality monitoring system can provide valuable insights into the presence of harmful pollutants and trigger appropriate actions, such as activating ventilation systems, sending notifications to users, or adjusting the environment to improve air quality.

The MQ135 gas sensor's compact size, cost-effectiveness, and compatibility with the NodeMCU ESP8266 make it an ideal choice for home air quality monitoring projects. Its ability to detect a wide range of gases provides users with comprehensive information about the air they breathe, promoting a healthier and safer indoor environment.

### C. DHT11

The DHT11 sensor is a key component of the home air quality monitoring system project, designed to measure temperature and humidity levels in the surrounding environment. It plays a crucial role in providing real-time data on these parameters, enabling users to monitor and maintain a comfortable and healthy indoor environment.

The DHT11 sensor consists of a capacitive humidity sensor and a thermistor for temperature measurement. The humidity sensor utilizes a moisture-sensitive capacitor that changes its capacitance based on the moisture content in the air. This capacitance variation is converted into a digital signal by the sensor's internal circuitry, providing accurate humidity measurements. The thermistor, on the other hand, is a type of resistor that exhibits a change in resistance with temperature. By measuring the resistance of the thermistor, the DHT11 sensor can accurately determine the ambient temperature. These measurements are then communicated to the microcontroller, such as NodeMCU ESP8266,through a single-wire digital interface, making it easy to integrate into the home air quality monitoring system.

In the context of the project, the DHT11 sensor is connected to the NodeMCU ESP8266, which serves as the central processing unit. The sensor communicates with the NodeMCU ESP8266 using a simple and standardized protocol, allowing the microcontroller to read the temperature and humidity values. With this information, the system can perform various actions, such as activating ventilation systems, displaying the current temperature and humidity on an LCD screen, or sending alerts to users' smartphones when certain thresholds are exceeded. The DHT11 sensor's affordability, simplicity, and reliable performance make it an excellent choice for monitoring and maintaining optimal air quality in homes.

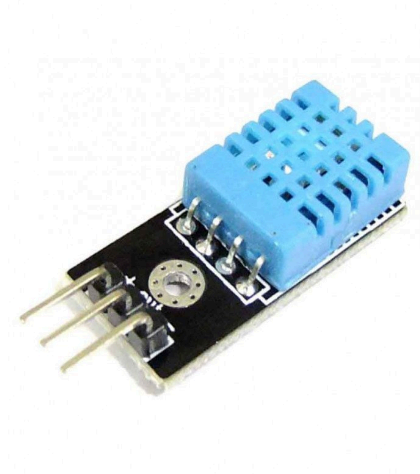

Fig. 3 : DHT11 Sensor

## II. System Design

The hardware implementation of the air quality monitoring system using NodeMCU ESP8266, MQ135 air quality sensor, and DHT11 sensor involves the following components and connections:

1. NodeMCU ESP8266 : The NodeMCU ESP8266 serves as the main microcontroller in the system. It is responsible for data acquisition, processing, and communication. The NodeMCU ESP8266 board is connected to the power supply and other components using jumper wires.

2. MQ135 Air Quality Sensor : The MQ135 sensor is used to detect various air pollutants. It is connected to the NodeMCU ESP8266 board via a jumper wire. The sensor requires a stable power supply and is connected to the appropriate pins on the NodeMCU board.

3. DHT11 Sensor: The DHT11 sensor measures temperature and humidity. It is also connected to the NodeMCU ESP8266 board using a jumper wire. Similar to the MQ135 sensor, the DHT11 sensor requires a stable power supply and is connected to the appropriate pins on the NodeMCU board.

4. Breadboard: The circuit setup includes a breadboard that provides additional connections and protection for the sensors

and microcontroller. The breadboard may contain resistors, capacitors, or other components necessary for proper circuit operation.

The power supply for the system is provided through a USB micro cable. The USB micro cable is connected to the power input on the NodeMCU ESP8266 board. It is important to ensure that the USB cable used can provide the necessary voltage and current for the circuit's operation. The exact voltage and current requirements will depend on the specifications of the NodeMCU board and the connected components.

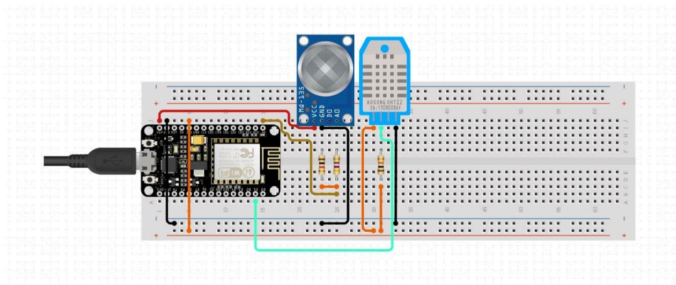

Fig 4 : Circuit Diagram

## III. Software Implementation & Working

Software Implementation and Working:

The software implementation of the Home air quality monitoring system using NodeMCU ESP8266, MQ135 air quality sensor, DHT11 sensor, and Thingspeak cloud server involves the following components and processes:

1. NodeMCU ESP8266 Programming:
The NodeMCU ESP8266 board is programmed using the Arduino IDE or other compatible programming environments. The programming code includes the necessary libraries and functions to read data from the MQ135 air quality sensor and DHT11 temperature and humidity sensor. The code also includes the Wi-Fi connectivity setup, where the SSID and password of the Wi-Fi network are provided.

2. Data Acquisition and Processing:
The programmed NodeMCU ESP8266 board continuously reads data from the MQ135 air quality sensor and DHT11 sensor. The data obtained from these sensors includes air quality parameters such as pollutant levels, temperature, and humidity. The acquired data is processed within the NodeMCU board to ensure accuracy and reliability.
3. Internet Connectivity:
The NodeMCU ESP8266 board establishes an internet connection using the provided Wi-Fi network credentials. This enables the board to connect to the Thingspeak cloud server

Power Supply:

for data transmission.

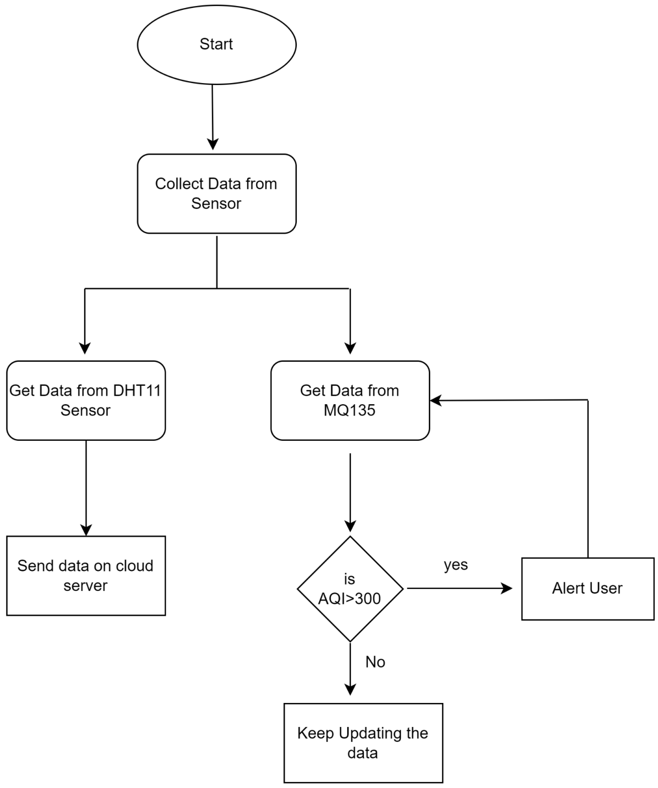


Fig 5 : flow chart

4. Thingspeak Cloud Server Integration:
The acquired and processed data from the sensors is sent to the Thingspeak cloud server using the Thingspeak API. The API key and channel ID, specific to the Thingspeak channel created for this project, are included in the NodeMCU program. The data is transmitted to the cloud server in real-time or at predefined intervals, depending on the programming logic.

5. Mobile App Development:
A mobile app is developed using MIT App Inventor or a similar platform to visualize the air quality and environmental data. The mobile app is designed to connect to the Thingspeak cloud server and retrieve the data from the specific channel created for this project. The app displays the air quality parameters, temperature, and humidity to the user in an intuitive and user-friendly manner.

6. Real-Time Monitoring:
With the integration of the Thingspeak cloud server and the mobile app, users can monitor the air quality and

environmental data in real-time. The data is updated and displayed on the mobile app as soon as new readings are received from the sensors and transmitted to the cloud server.

## IV. Results

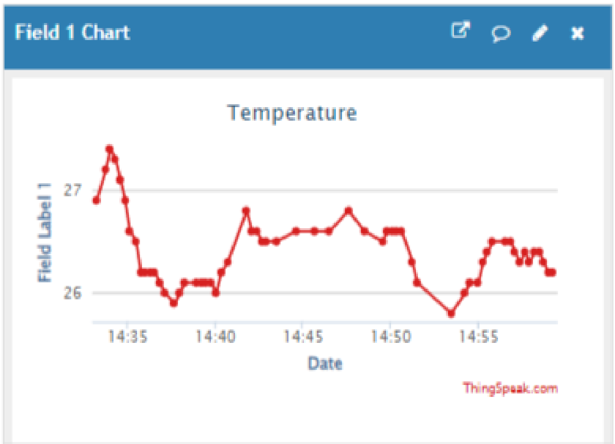


Fig. 5 - Temperature Readings

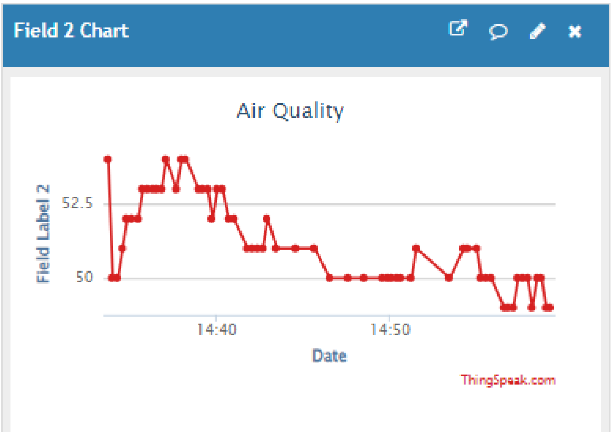


Fig. 6 - Humidity Readings

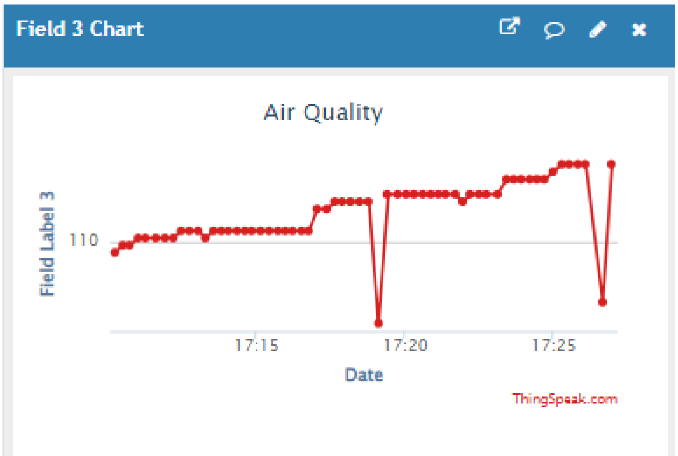


Fig. 7 - Air Quality Index Readings


Fig.8 - Real Time Data Displayed on Mobile App

## V. Conclusion

In conclusion, the project "Air Quality Monitoring System using NodeMCU ESP8266, MQ135 Air Quality Sensor, DHT11 Sensor, Thingspeak Cloud Server, and Mobile App created using MIT App Inventor" has successfully achieved its objectives of developing a comprehensive and efficient solution for monitoring air quality in real-time.

Through the integration of the NodeMCU ESP8266 board, MQ135 air quality sensor, and DHT11 sensor, the system is capable of accurately measuring air quality parameters such as pollutant levels, temperature, and humidity. The data obtained from these sensors is then transmitted to the Thingspeak cloud server using the Wi-Fi module connected to the NodeMCU board.

The Thingspeak cloud server acts as a central repository for the collected data, allowing users to access and monitor air quality information remotely. The mobile app, developed using MIT App Inventor, provides an intuitive interface for users to visualize the air quality data retrieved from the Thingspeak cloud server. This enables users to stay informed about the air quality in their surroundings and make informed decisions regarding their health and well-being.

The project has demonstrated the successful integration of hardware components, software programming, and cloud-based data storage and visualization. The system's real-time monitoring capabilities provide users with up-to-date and accurate information, enhancing their awareness of the air quality conditions in their environment.

In summary, the air quality monitoring system using NodeMCU ESP8266, MQ135 air quality sensor, DHT11 sensor, Thingspeak cloud server, and mobile app developed using MIT App Inventor presents an effective and efficient solution for monitoring air quality parameters. The successful implementation of this system contributes to the field of environmental monitoring and provides valuable insights for individuals, communities, and organizations striving to maintain a healthy and sustainable living environment.

## VI. Future Scope

1. Integration of Additional Gas Sensors:
As mentioned earlier, the current system utilizes the MQ135 air quality sensor to measure air pollutants. A future enhancement could involve integrating additional gas sensors such as MQ-7 (carbon monoxide sensor) or MQ-3 (alcohol sensor) to monitor a wider range of pollutants. This would provide a more comprehensive understanding of the air quality and enable users to identify specific contaminants.

2. Data logging and historical analysis: Incorporating a data logging functionality within the NodeMCU board can enable the system to store air quality data over time. This data can be used for historical analysis, trend identification, and long-term monitoring of air quality in a given environment.

3. Geolocation and mapping: Integrating geolocation capabilities into the system can provide more contextual information about air quality in specific locations. The collected data can be plotted on a map, allowing users to visualize air quality variations across different areas or regions.

4. Integration with smart home systems: Connecting the air quality monitoring system with existing smart home systems can enable automation and triggers based on air quality conditions. For example, if the air quality deteriorates, the system can automatically activate air purifiers or adjust ventilation systems to improve indoor air quality.

5. Enhancing energy efficiency: Optimizing power consumption and implementing energy-saving features can prolong the system's battery life and reduce overall energy usage. This can be achieved through sleep modes, dynamic sensor sampling rates based on air quality levels, or integrating renewable energy sources.

6. Advanced data analytics: Utilizing advanced data analytics techniques, such as machine learning algorithms, can provide more accurate predictions, identify patterns, and generate insights from the collected air quality data. This can help users make informed decisions and take proactive measures to address air quality concerns.

7. Integration of Actuators:
Integrating actuators with the air quality monitoring system can significantly improve its functionality. For instance, when the temperature falls below a certain predefined level, the system can automatically activate fans or heating devices to maintain a comfortable indoor environment. This automation feature would enhance user comfort and convenience.

## VII. References


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