SMART AIR PURIFIER
WITH AQI INDEX
MONITORING

PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report "SMART AIR PURIFIER WITH AQI INDEX MONITORING" is a Bonafide work of RITHIKKA.A (714023106083), VIJAY PRINCE.BL (714023106114), VIGNESH.S (714023106113), SUJEETH.V.C (714023106307) who carried out the project work under my supervision.

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TITLE

ABSTRACT

The **Smart Air Purifier with AQI Index Monitoring** is a microcontroller-based system designed to improve indoor air quality by integrating automated purification with real-time air quality assessment. The device continuously monitors air pollution levels using sensors and intelligently adjusts the purifier's performance to maintain clean air. A digital or mobile interface displays current air quality data, allowing users to stay informed and take necessary precautions. This smart system enhances health and energy efficiency while offering a modern, user-friendly solution for maintaining safe indoor environments. The Smart Air Purifier with AQI Index Monitoring is a microcontroller-based system designed to improve indoor air quality by integrating automated purification with real-time air quality assessment.

The device continuously monitors air pollution levels using sensors and intelligently adjusts the purifier's performance to maintain clean air. A digital or mobile interface displays current air quality data, allowing users to stay informed and take necessary precautions. This smart system enhances health and energy efficiency while offering a modern, user-friendly solution for maintaining safe indoor environments. It is especially beneficial in urban areas where air pollution levels often fluctuate dramatically. The system can be integrated with IoT platforms to enable remote monitoring and control. Customizable thresholds for AQI alerts help users take timely action to protect their health. Low-power components ensure the device is energy-conscious and suitable for long-term use. The modular design allows easy maintenance and upgrades, promoting sustainability and longevity

CHAPTER 1
INTRODUCTION

Air pollution is one of the most critical environmental issues affecting human health and well-being. With the rapid pace of industrialization, urban growth, increased vehicular use, and reduced green cover, the concentration of harmful pollutants in the air has risen drastically.

While outdoor pollution is frequently addressed in policy and media, **indoor air pollution often goes unnoticed**, despite the fact that people spend up to **90% of their time indoors**. Poor indoor air quality can lead to a variety of health problems including asthma, allergies, eye irritation, fatigue, and even long-term respiratory illnesses.

In this context, the need for **an intelligent, automated, and real-time air purification system** becomes essential. Traditional air purifiers operate on fixed settings and lack the capability to respond dynamically to changing pollution levels. Moreover, they provide limited feedback to users about the actual condition of the air they are breathing. To bridge this gap, we propose a **Smart Air Purifier with AQI Index Monitoring**—a modern solution that combines **air purification with digital intelligence**.

This smart system is **microcontroller-based** and integrates multiple environmental sensors to continuously monitor indoor air quality parameters such as PM2.5, PM10, VOCs, temperature, and humidity.

Based on real-time sensor readings, the system calculates the **Air Quality Index (AQI)** and displays it via a user interface—either a screen or mobile app. More importantly, the system automatically adjusts the purifier's speed or operation mode depending on the detected pollution level, ensuring efficient energy use and consistent air cleanliness.

The system is designed with **IoT capability**, allowing users to monitor and control air quality remotely. Alerts and notifications can be generated if pollution crosses a dangerous threshold, thereby keeping users informed and safe. The project aims to provide a **cost-effective, user-friendly, and eco-conscious air purification solution** that ensures better living conditions, especially in urban homes, hospitals, schools, and offices.

Overall, the **Smart Air Purifier with AQI Index Monitoring** not only improves health and comfort but also contributes to environmental sustainability by promoting energy-efficient technology. It serves as an excellent example of how embedded systems and automation can be used to solve real-world problems in innovative ways.

1.1ABOUT PROJECT

The **Smart Air Purifier with AQI Index Monitoring** is an innovative and practical embedded system designed to automatically monitor and improve indoor air quality. With increasing concerns about pollution and health, especially in urban settings, this project combines real-time sensing, control, and automation to ensure clean air in indoor environments. The system is built using key components such as the **ESP32 microcontroller**, **gas sensor (MQ135 or similar)**, **LCD display**, and **relay module**, each playing a crucial role in the functioning of the purifier.

At the heart of the project is the **ESP32**, a powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities. It acts as the brain of the system, collecting data from sensors, processing it, calculating the **Air Quality Index (AQI)**, and controlling output devices. The **gas sensor** detects various harmful gases and airborne pollutants such as carbon monoxide (CO), ammonia (NH_3), nitrogen dioxide (NO_2), and volatile organic compounds (VOCs). Based on the concentration of these pollutants, the system calculates the AQI, which is a standardized indicator of air quality.

The calculated AQI is then displayed on an **LCD screen**, allowing users to view real-time air quality levels. Depending on the air quality, the ESP32 triggers a **relay module**, which controls the air purifier (fan or motor). When pollution levels exceed a predefined threshold, the relay is activated to switch on the purifier. Once air quality improves, the system can automatically turn the purifier off, thereby optimizing energy consumption and increasing the system's efficiency.

CHAPTER 2

LITERATURE REVIEW

. Air pollution has become a critical concern in both urban and indoor environments due to its severe impact on human health and well-being. Several studies have highlighted the correlation between poor air quality and respiratory, cardiovascular, and neurological disorders. Traditional air purifiers operate based on manual settings or pre-defined schedules, lacking adaptability to real-time environmental changes. As a result, recent research has focused on integrating smart technologies with air purification systems to improve efficiency and automation.

Kumar et al. (2018) explored the integration of IoT-based air monitoring systems using gas sensors and microcontrollers to detect pollutants like CO, NO_2, and PM2.5. Their work emphasized the need for continuous monitoring and dynamic response mechanisms to ensure optimal indoor air quality. Another study by Sharma and Mehta (2019) implemented a smart air purification system using Arduino and Wi-Fi modules to remotely monitor and activate purification cycles, which reduced energy consumption and enhanced user convenience.

The use of the **ESP32 microcontroller** has been widely recommended in literature due to its low power consumption, dual-core processing, and built-in Wi-Fi/Bluetooth features. Researchers like Singh et al. (2020) demonstrated how ESP32, combined with gas sensors such as MQ-135 and SDS011, can effectively measure air pollutants and communicate data to IoT dashboards in real time. Similarly, LCD displays have been used in multiple projects to provide immediate visual feedback of the Air Quality Index (AQI) to users..

In conclusion, the existing literature supports the implementation of a **Smart Air Purifier with AQI Index Monitoring** by combining ESP32, air quality sensors, and relay-controlled purification mechanisms. These systems are cost-effective, scalable, and provide real-time feedback, making them a valuable solution to combat indoor air pollution efficiently

CHAPTER 3
PROPOSED SYSTEM

The proposed system aims to design and implement a **Smart Air Purifier** integrated with **Air Quality Index (AQI) monitoring** using real-time sensor data and automated purification control. The system is built around the **ESP32 microcontroller**, which serves as the central processing and communication hub. It collects data from multiple air quality sensors, processes the AQI, and controls the purification system accordingly.

The **gas sensor (e.g., MQ-135)** is used to detect harmful gases and pollutants like CO_2, NH_3, and other volatile organic compounds (VOCs). Additionally, **particulate matter sensors** (such as PMS5003 or SDS011) may be used to measure PM2.5 and PM10 concentrations. The sensor readings are interpreted using standard AQI calculation algorithms, and the resulting AQI value is displayed on a **16x2 or 20x4 LCD screen** for user visibility.

Based on the AQI level, the system intelligently activates the air purifier components. A **relay module** is used to control the operation of a fan, motor, or filter system. For instance, if the AQI crosses a predefined threshold (e.g., 150), the purifier turns ON automatically, increasing airflow or filtration power. When air quality improves, the system turns OFF or reduces intensity, saving energy and extending component life.

The ESP32's **Wi-Fi capability** can optionally connect the system to a mobile app or IoT dashboard, allowing remote monitoring and control. Notifications and logs of air quality trends can also be integrated for long-term analysis. The system is powered by a regulated DC source, ensuring safe and stable operation.

In essence, this proposed system combines **real-time environmental monitoring** with **automated air purification**, resulting in a smart, energy-efficient, and user-friendly solution for improving indoor air quality. Its modular design also makes it scalable and adaptable to different room sizes and environmental needs.

3.1 BLOCK DIAGRAM:

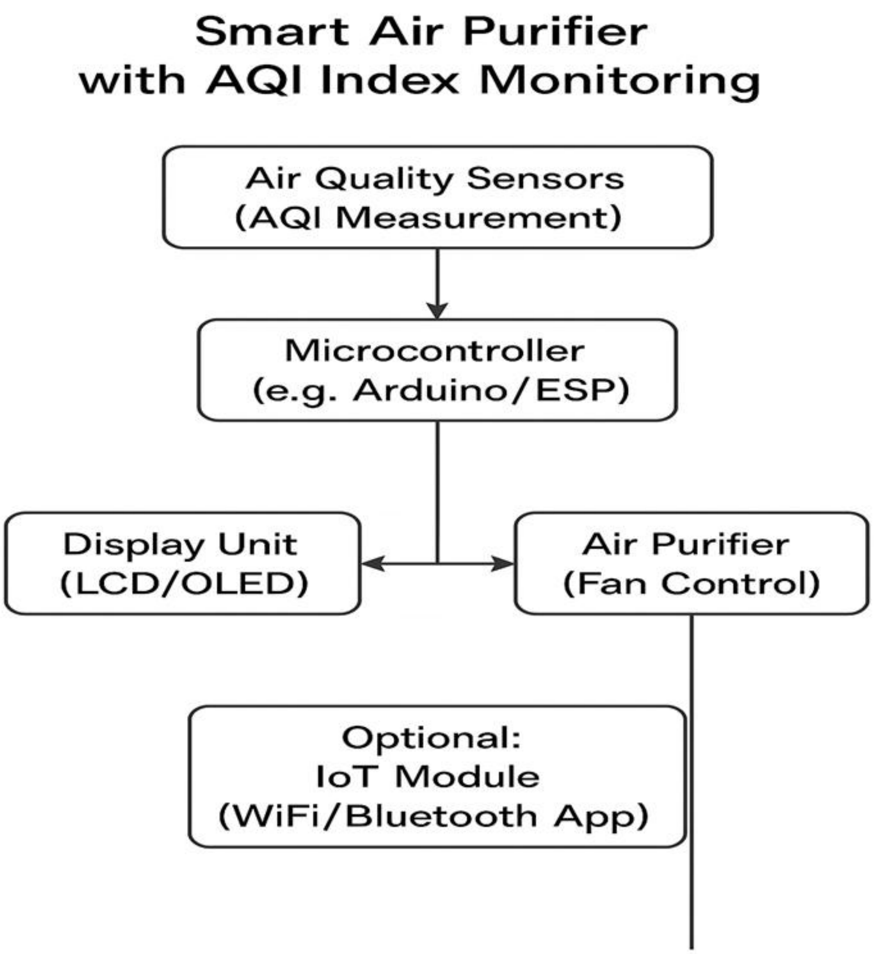
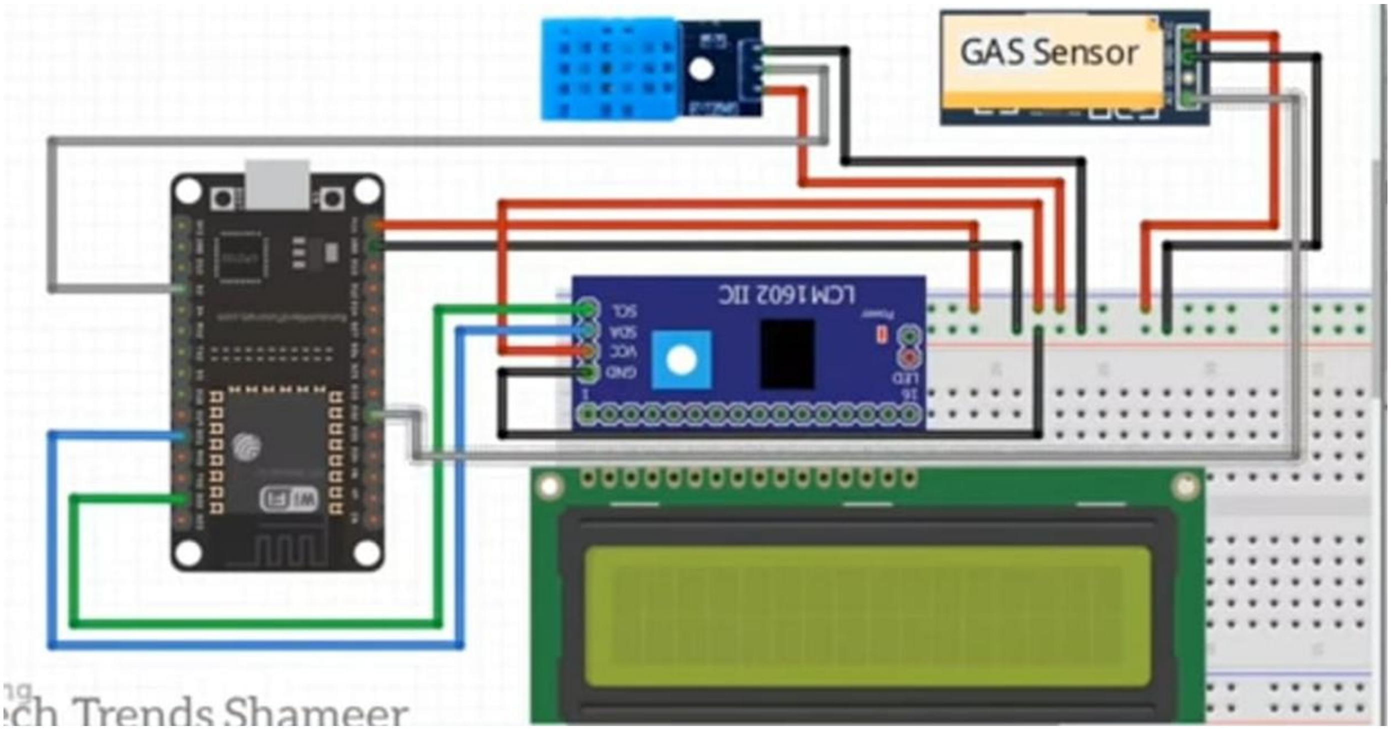


Fig 3.1 Block daigram Proposed System

The proposed system's block diagram illustrates an advanced AQI sensor. It includes an AC supply to power the components, an ESP32 for processing and controlling operations, and a IOT module. **Fig 3.1 Block daigram Proposed System.** The Smart Air Purifier system uses the ESP32 microcontroller as the central unit, which receives data from air quality sensors (e.g., MQ-135) to calculate the AQI. Based on the AQI value, it displays the result on an LCD display and controls a fan or filter unit using a relay module. The system operates automatically, adjusting purification intensity according to pollution levels.

3.2 CIRCUIT DIAGRAM



CHAPTER 4

METHODOLOGY

To configure the system uses gas sensors to detect air pollutants and sends data to the ESP32 microcontroller for AQI calculation. Based on the AQI value, it displays the result on an LCD and automatically controls the purifier via a relay.

4.1 HARDWARE REQUIREMENTS:

- ESP -32
- POWER SUPPLY
- WIRES
- MQ-135 SENSOR
- RELAY

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4.2 Software Requirements:

- MATLAB
- THINGSPEAK

4.3.MQ 135 Gas Sensor

The **MQ-135 gas sensor** is a key component used to **detect air pollutants** and assess **indoor air quality**. It plays a critical role in estimating the **Air Quality Index (AQI)** in real-time.

4.3.1 ESP 32

The ESP32 is a powerful and versatile microcontroller developed by Espressif Systems, designed specifically for Internet of Things (IoT) applications. It features a dual-core Tensilica LX6 processor running at up to 240 MHz, providing high processing power while maintaining low energy consumption. One of the key advantages of the ESP32 is its built-in wireless communication capabilities, supporting both Wi-Fi (802.11 b/g/n) and Bluetooth (classic and BLE), which allows seamless connectivity for smart devices. Additionally, the ESP32 includes a rich set of peripherals such as GPIO pins, ADCs, DACs, SPI, I2C, UART, and PWM, enabling it to interface with various sensors, actuators, and displays.

Due to its high performance and extensive connectivity options, the ESP32 is widely used in smart automation, environmental monitoring, wearable devices, and other embedded systems. It supports multiple programming environments, including the Arduino IDE and Espressif's ESP-IDF, making development accessible and efficient. In projects like the Smart Air Purifier with AQI Index Monitoring, the ESP32 serves as the central control unit that processes sensor data, manages air quality calculations, and controls purification hardware, while also enabling remote monitoring through Wi-Fi connectivity. Its combination of power, flexibility, and wireless features makes the ESP32 an ideal choice for modern IoT solutions.

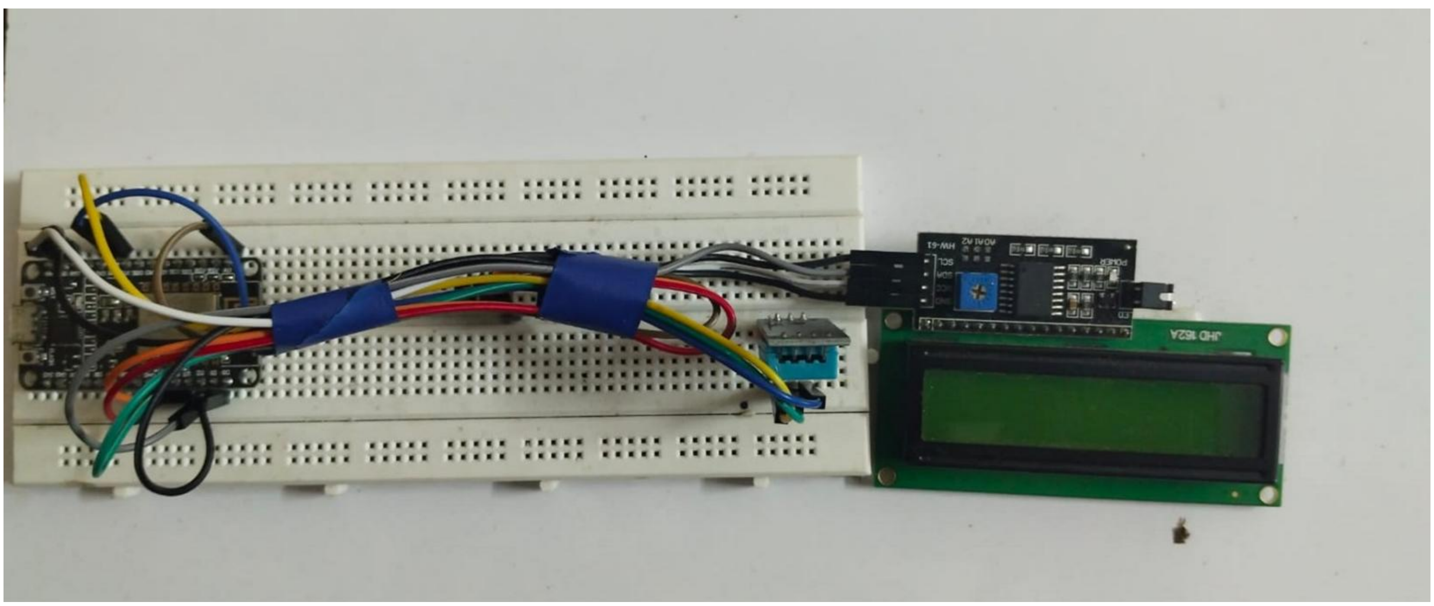
CHAPTER 5

RESULT AND OUTPUT

5.1 RESULT

The Smart Air Purifier system continuously monitors indoor air quality using gas sensors. It calculates the AQI and displays the real-time value on an LCD screen for user awareness. When the air quality drops below safe levels, the system automatically activates the purifier. The fan or filtration unit operates until the air quality improves to an acceptable range. This ensures cleaner air while conserving energy through intelligent control.

5.2 OUTPUT



CHAPTER 6

CONCLUSION:

- The Smart Air Purifier with AQI Index Monitoring successfully demonstrates how technology can be leveraged to improve indoor air quality through automation and real-time monitoring. By integrating air quality sensors with a responsive purification system, the project provides an efficient and intelligent solution to reduce indoor pollution and promote healthier living environments. The system not only enhances user comfort and safety but also increases awareness about air quality levels. With potential for further development, such as IoT integration and mobile app control, this project lays the foundation for smart, sustainable, and user-centric air purification systems. With growing concerns about air pollution, especially in urban areas, such smart systems can play a vital role in preventive healthcare. Future enhancements could include cloud-based data storage, AI-driven pollution prediction, and integration with smart home ecosystems to further improve functionality and user experience.

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