

## SOLAR POWERED AIR QUALITY MONITORING WITH SMART IOT FEEDBACK

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### ABSTRACT

Rapid urbanization, industrialization, and rising vehicle emissions have made air pollution a major global concern that poses considerable threats to both the environment and human health. Long-term exposure to contaminated air causes heart problems, respiratory conditions, and a lower standard of living. The effectiveness and sustainability of conventional air purifiers are limited by their reliance on grid electricity and lack of real-time monitoring or feedback. To address these concerns, this project proposes a Solar Powered Air Purifier with Smart IoT Feedback, aimed to give an eco-friendly and intelligent solution for air quality control. By using solar energy as the main power source, the suggested method lessens reliance on traditional electricity and encourages the use of renewable energy. Pollutant levels are continuously monitored by air quality sensors, and an embedded controller processes the data that is gathered. Real-time data on air quality is sent to a cloud platform via IoT connectivity for tracking, analysis, and feedback. The system gives notifications and status updates through a web or mobile interface, enabling users to track air quality conditions remotely. This clever and sustainable strategy enhances the effectiveness of purification, promotes environmental preservation, and advances the creation of intelligent and environmentally friendly technologies.

**Keywords:**MQ135 Sensor, DHT11 Sensor, Embedded system.

### I INTRODUCTION

Rapid urbanization, industrial expansion, and the rise in automobile ownership have made air pollution a significant environmental and public health concern. Human health is greatly impacted by the presence of dangerous chemicals and particulate matter in the environment, which can result in respiratory conditions, heart problems, and a lower standard of living. Therefore, it is crucial to continuously monitor air quality in order to determine pollution levels, raise awareness, and take prompt preventive action. However, traditional air quality monitoring systems are inadequate for extensive and real-time monitoring, particularly in distant and outdoor areas, because

they are frequently costly, power-hungry, and restricted to fixed sites.

By combining renewable energy technology with contemporary embedded systems and Internet of Things (IoT) concepts, the Solar Powered Air Quality Monitoring with Smart IoT Feedback system overcomes these constraints. This system's main power source is solar energy, which guarantees continuous operation while lowering reliance on traditional electricity and encouraging environmentally good behaviours. Pollutants including smoke and dangerous gasses are detected by a variety of air quality sensors, and a microcontroller processes the information gathered. IoT connection is then used to send the processed

data to a cloud platform, allowing for remote access and real-time monitoring from any location.

By offering real-time air quality updates, alarms, and notifications when pollution levels surpass acceptable limits, smart IoT feedback significantly contributes to raising user awareness. Users can efficiently monitor environmental conditions thanks to the system's ability to display air quality data both locally and on web or mobile applications. The suggested system provides an affordable, energy-efficient, and scalable solution for ongoing air quality monitoring by fusing solar power, sensor technologies, and Internet of Things connectivity. In addition to promoting sustainable development objectives, this project helps make homes, schools, hospitals, businesses, and smart cities healthier places to live.

## II LITERATURE SURVEY

Due to its capacity to offer real-time data collecting, wireless transmission, cloud storage, and remote environmental condition visualization, the use of Internet of Things (IoT) technology in air quality monitoring has attracted a lot of interest lately. A wireless air quality tracking system that used sensor networks to identify pollutants and provide data remotely was first presented by S. Tadepalli (2016). Although this study showed that wireless monitoring was feasible, the system was dependent on traditional power supply because it was not integrated with renewable energy sources.

In 2018, several researchers contributed to the development of air monitoring and purification technologies. M. Kumar et al. (2018) fabricated a solar-powered air purifier, proving that renewable energy can effectively support air purification processes while reducing reliance on grid electricity. Similarly, P. Brieger and A.

Bergmann (2018) developed a cloud-connected air pollution sensor network that enabled real-time data storage and visualization through cloud platforms. Their work highlighted the importance of connectivity in environmental monitoring systems. P. D. Landge and R. R. Harne (2018) proposed an air quality monitoring system designed for city environments, emphasizing continuous pollution tracking to support smart city initiatives. In the same year, B. R. Subrahmanyam et al. (2018) introduced an air purification system targeting street-level and roadside pollution, focusing on automated methods of purification to lower the concentration of pollutants in heavily impacted metropolitan areas.

As sensor-based detection and IoT technologies were integrated, research progressed. A sensor-based gas leak detection system that offered real-time warnings for dangerous gas emissions was presented by M. Khan (2020). This work reaffirmed the significance of inexpensive sensors and microcontrollers in environmental monitoring applications, despite its primary focus on safety. Similarly, X. Xiaojun et al. (2020) created an air pollution monitor that can measure several environmental factors, allowing for precise pollution assessment in real time.

Significant advancements in integrating solar energy with Internet of Things-based monitoring systems were made in 2021. In order to show how renewable energy may assist sustainable and energy-efficient environmental solutions, P. M. Bhagya P. K., A. Kumar N., and N. M. U. (2021) created a solar-powered air purifier integrated with air quality monitoring. By creating a solar-powered air purifier that can automatically react to pollution levels using gas and particulate matter sensors, A. Chakravarthy et al. (2021) improved this

idea even further. Furthermore, R. B. Madane et al. (2021) suggested an Internet of Things-based air factors monitoring system that improved accessibility and user awareness by enabling remote monitoring and cloud-based data analysis. Using an air pollution monitoring system, S. Das,

M. Paul, and S. Nayak (2021) investigated the effect of COVID-19 on the Air Quality Index, emphasizing the significance of trend visualization and historical data analysis for environmental decision-making.

A solar air purifier with integrated air monitoring capabilities was created more recently by Mrs. K. Thanuja and Mr. N. S. Swaroop (2023), with a focus on continuous operation via solar panels and battery backup. Their work highlights the increasing trend toward intelligent, energy-efficient, and sustainable air quality solutions that may be deployed in both urban and rural areas.

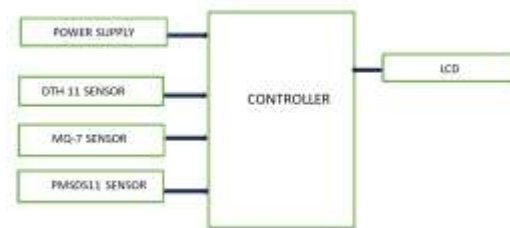
### III EXISTING SYSTEM

The IoT-Based Air Quality Index Monitoring System is an advanced environmental tracking system that offers real-time atmospheric safety information. The MQ-7, DHT 11, and PM SDS011 are among the specialized sensors that continually sample the ambient air at the data collection layer, which is where the system's design starts. While the SDS011 laser sensor finds small particulate matter, such as PM2.5 and PM10, which present serious respiratory hazards, the MQ-7 sensor focuses on carbon monoxide, a hazardous and odorless gas. The DHT 11 sensor, which measures humidity and temperature to give context for how these contaminants might be spreading in the surrounding area, complements this.

The Arduino microcontroller, the brain of the system, is at the centre of the hardware. It carries out the crucial function of signal processing and controls the electrical flow from

the power source. The Arduino computes useful air quality data using the digital pulses and fluctuating voltage levels from the sensors. Complex computations are involved in this processing, such as translating raw data into micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) or parts per million (ppm). The data is transferred to an IoT interface, usually a Wi-Fi-enabled module like the Node MCU, after these computations are finished. In order to ensure that the local environment is appropriately reproduced in the virtual world, this module serves as a gateway, bridging the gap between physical hardware and the digital cloud.

### Block Diagram



The Mobile App represents the user interface layer, which is the last phase of the system. This program converts the unprocessed technical data into a user-friendly dashboard. The viewer sees a simplified Air Quality Index (AQI) score, frequently with color-coded alerts indicating if the air is healthy, moderate, or hazardous, rather than raw voltages or complicated statistics. This real-time connectivity enables for fast decision-making, such as activating home air purifiers or avoiding outside activity during high-pollution occasions. By combining these different technologies, the system gives people and communities an easy method to keep an eye on the health of their surroundings and take preventative action against air pollution.

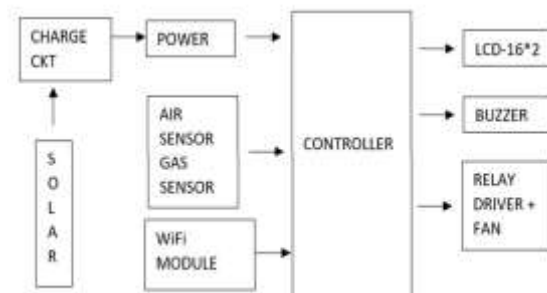
### IV PROPOSED SYSTEM

The suggested Solar-Powered Air Purifier with Smart IoT Feedback is a clever and

environmentally friendly way to use renewable energy to monitor and enhance air quality. Because the system is mostly powered by solar energy, it can be used in outdoor and isolated areas without access to traditional electricity. To guarantee continuous functioning, solar energy produced by photovoltaic panels is controlled and stored in a rechargeable battery. Effective power management improves system dependability and lowers energy losses. Utilizing sustainable energy promotes environmental sustainability and reduces operating costs. The general design emphasizes on long-term usage and minimum human interaction. Hence, the technology provides a viable response to escalating air pollution concerns. The fundamental component of the system's operation is the air quality monitoring and processing unit. Various gas sensors are used to detect dangerous gases such as carbon monoxide, carbon dioxide, and volatile organic compounds, while particulate matter sensors measure PM2.5 and PM10 levels. Temperature and humidity sensors are included to improve accuracy and assess environmental conditions. The microcontroller, which serves as the system's brain, gathers and processes all sensor data. It uses calibration methods and predetermined thresholds to transform raw information into usable air quality measurements. Sensing, data processing, and control actions are all smoothly coordinated by the microcontroller. This makes it possible to evaluate air quality in real time with accuracy and dependability.

System intelligence and user engagement are improved by the intelligent IoT feedback and control unit. Wi-Fi-enabled modules transfer real-time air quality data to a cloud platform for remote monitoring and visualization. This data is accessible to users via computers or smartphones, enabling ongoing observation

from any location. Displays and alarm systems provide local feedback for instant awareness. The technology can automatically turn on linked exhaust fans or air purifiers when pollution levels rise above safe thresholds. Without the need for human intervention, this closed-loop feedback system guarantees prompt remedial action. All things considered, the suggested method offers a sustainable, clever, and effective way to monitor and purify air quality.



## V HARDWARE DESCRIPTION

### ARDUINO UNO:

Arduino is an open-source hardware and software company, project, and user community that designs and produces single-board microcontrollers and microcontroller kits for use in digital devices and interactive things that can sense and operate both physically and digitally. Thanks to the GNU Lesser General Public License (LGPL) or GNU General Public License (GPL) licenses for its products, anybody can construct Arduino boards and distribute its software. There are do-it-yourself (DIY) kits and commercial preassembled Arduino boards.



**Fig.1 ARDUINO UNO BOARD**  
**DHT11**



**Fig.2 DHT11 SENSOR**

DHT-11 It is a digital sensor capable of correctly sensing temperature and humidity. It's compatible with a wide range of microcontrollers, including Arduino and Raspberry Pi, providing seamless integration for fast measurement of humidity and temperature.

**MQ135:**



**Fig.3 MQ135**

This air quality sensor, which is a member of the MQ gas sensor series, is frequently used to identify smoke and dangerous gases in the surrounding air.

**LCD**

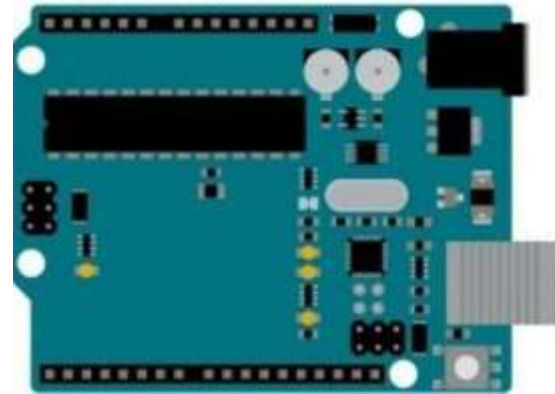


**Fig.4 LCD**

Its purpose is to show the general data and readings.

**Arduino UNO**

It is a microcontroller board based on a detachable, dual-inline-package (DIP) ATmega328 AVR microprocessor.



**Fig. 5 Arduino UNO**

**Solar panel:**



**Fig.6 Solar panel**

The solar power unit turns sunlight into electrical energy, providing a reliable supply of power for the system. The system's use of solar energy greatly lessens reliance on traditional grid power, making it appropriate for places with poor access to electricity. This strategy encourages the use of renewable, eco-friendly energy sources, which lowers carbon emissions. Furthermore, the system is made to function well in both indoor and outdoor settings, guaranteeing adaptable and sustainable use.

**Buzzer:**



**Fig.7** Buzzer

A piezo buzzer is an electronic sound-producing gadget that functions utilizing a piezoelectric crystal. The crystal vibrates and produces a tone or beep when an electrical voltage is introduced. It is widely utilized in numerous applications because to its straightforward design, low power consumption, and dependable functioning. Piezo buzzers are extensively deployed in alert and alarm systems to offer aural alerts. Additionally, they are utilized in industrial systems to indicate fault states or alerts, timers, doorbells, Arduino, and Internet of Things projects.

### Relay Module



**Fig.8** Relay module

Electrical loads like lights and fans are managed by the relay module. The microcontroller turns on or off the relay based on the number of visitors. This aids in basic automation, but it can only be used on-site without a remote control.

### VI RESULTS

The findings of the suggested Solar Powered

Air Quality Monitoring and Air Purifier System with Smart IoT Feedback clearly suggest that the initiative has effectively achieved its stated objectives. Temperature, humidity, particulate matter, hazardous gases, and other air quality indicators are all reliably and efficiently monitored by the system. Utilizing solar energy as the main power source greatly lessens reliance on traditional grid electricity and shows effective usage of renewable energy. Battery backup increases system dependability by ensuring continued operation in poor light and at night. The microcontroller's real-time data processing makes it possible to accurately assess environmental conditions using predetermined thresholds. Through cloud platforms, IoT technology integration enables ongoing remote monitoring, data logging, and visualization. Local displays and buzzer alarms provide fast feedback and timely cautions to consumers. Automatic control functions, such turning on exhaust fans or air purifiers, improve system safety and responsiveness. The system is adaptable for a range of applications and operates effectively in both indoor and outdoor settings. Sustainable energy use and low electricity use lower overall operating costs. The project effectively integrates renewable energy, sensor technology, and embedded systems to produce a proactive and intelligent safety solution. For real-time air quality monitoring and pollution management, the system therefore proved to be useful, affordable, and environmentally sustainable.

### VII CONCLUSION

The Solar-Powered Air Quality Monitoring and Control System offers a dependable, efficient, and long-lasting answer to contemporary environmental safety issues. The system guarantees continuous operation even in locations with inconsistent or non-existent grid power by combining renewable solar energy

with embedded technologies and Internet of Things technology. Efficient power management and battery backup boost system stability during low sunlight situations. The system continuously monitors essential air quality factors such as hazardous gasses, particulate matter, temperature, and humidity. Real-time data processing by the microcontroller provides accurate evaluation of environmental conditions. This initiative actively reduces risks by automatically regulating exhaust fans or air purifiers, in contrast to traditional systems that merely offer passive monitoring. Local notifications through LCD displays and buzzers ensure rapid awareness for on-site users. IoT connectivity offers remote monitoring, data visualization, and long-term analysis through cloud platforms. Both users and supervisors benefit from increased accessibility and situational awareness. The architecture's scalability and modularity make it simple to add more sensors. In both indoor and outdoor settings, the system operates effectively. The usage of renewable energy lowers operating costs. All things considered, the project effectively blends automation, intelligence, and sustainability. For proactive air quality monitoring and environmental protection, it is therefore a workable and future-ready option.

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