AIR QUALITY MONITORING SYSTEM

Dr. Anitha N
Assistant Professor
Department Of Electronics and Communication engineering
Sri Sairam Engineering college
TamilNadu, India
anitha.ece@sairam.edu.in

Anne Caroline S
Department Of Electronics and Communication Engineering
Sri Sairam Engineering college
TamilNadu,India
sec21ec103@sairamtap.edu.in

Shalini P
Department Of Electronics and Communication Engineering
Sri Sairam Engineering college
TamilNadu, India
sec21ec011@sairamtap.edu.in

Trisha V
Department Of Electronics and Communication Engineering
Sri Sairam Engineering college
TamilNadu,India
sec21ec168@sairamtap.edu.in

2023 Intelligent Computing and Control for Engineering and Business Systems (ICCEBS) | 979-8-3503-9458-0/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICCEBS58601.2023.10448553

Abstract—Air pollution is on the rise in the current circumstances, posing a significant threat to public health. According to the United Nations World Health Organization, 99% of urban residents worldwide are exposed to polluted air, leading to various health issues. The proposed system aims to enhance the quality of indoor air using Arduino UNO integrated with sensors. It employs Optical dust sensor and MQ-135 sensor to monitor dust, pollen, and smoke levels in the atmosphere. The collected data is utilized to analyze and calculate the Air Quality Index (AQI), which is then displayed on the LCD screen. If the AQI value surpasses safe limits (>400ppm), an alert is triggered, accompanied by blinking LEDs to signal the presence of harmful levels of air in the vicnity.

Keywords - Air Quality Index (AQI), Arduino UNO, Real - time monitoring.

I.INTRODUCTION

In an age defined by urbanization and industrialization, the quality of air we breathe has become of utmost importance for the health and welfare of urban people around the world. The deleterious effects of poor air quality on the environment and human health highlight the urgent need for efficient air quality monitoring methods. This project uses Arduino-based technology along with cutting-edge sensors to monitor air quality in urban settings. Urban areas represent epicenters of diverse pollutant sources, including vehicular emissions, industrial operations and construction activities, making them focal point for air quality issues. Traditional air quality monitoring systems, while reliable, often fall short in terms of affordability, scalability and accessibility, rendering them inadequate for comprehensive urban air quality assessment. By utilizing the potential of Arduino microcontrollers in conjunction with precise sensors for the continuous monitoring of crucial air quality parameters, such as particulate matter (PM2.5), carbon dioxide (CO_2) , smoke, Ammonia (NH_3) and Sulphur (S). This project strategically uses a network of Arduino-based sensors throughout urban areas to capture real-time data on air quality. The primary goals of the project include:

1. Cost-Effective Solution: Leveraging readily available and affordable Arduino hardware, this system offers a cost-effective approach to air quality monitoring, enabling its deployment in resource-constrained settings.

2. High Data Resolution: High-resolution data from the network of Arduino sensors makes it easier to identify regional sources of pollution and spatial variations in air quality.

3. Data Analysis and Visualization: Advanced data analysis and visualization techniques are employed to process and interpret the collected data, yielding insights into air quality trends and fluctuations.

4. Local Empowerment: The strategy encourages grassroots environmental stewardship by empowering local communities and organisations to actively participate in monitoring and resolving air quality issues.

5. Scalability and Replicability: By documenting the design, sensor configurations and data processing methodologies in detail, other researches and communities can replicate this system in diverse urban environments. Scalability encourages the development of a wider network of air quality monitoring programmes, resulting in a deeper comprehension of the global difficulties posed by poor air quality.

6. Policy Support: The information produced by our system can be a useful source of information for the development of evidence-based policy, allowing government agencies to implement specialised actions and rules to enhance air quality.

II. LITERATURE SURVEY

[1]The vital issue of indoor air quality through IoT-based technology, created a system utilizing ESP32 as a controller and multiple sensors to periodically monitor temperature, humidity, dust particles, and various polluting gases (H_2S, NH_3, CO, NO_2, and SO_2). In [2], a low-power device that monitors air qualityincluding CO_2, temperature, and

979-8-3503-9458-0/23/$31.00 ©2023 IEEE

humidity, and sends data to the cloud for continuous monitoring and storage. [3] An air purification system for vehicles that not only filters contaminants but also monitors air quality,safety, with test results indicating its superior performance compared to existing vehicle air purifiers. [4] An Indoor Air Quality Monitoring System (IAQMS) capable of real-time measurement of various air parameters, empowering stakeholders to make informed decisions for better indoor air quality. [5] Acost-effective and reliable air quality monitoring system coupled with IoT capabilities to address global air quality issues, particularly in regions lacking reference monitoring stations. [6] A Distributed Air Quality Monitoring System (DAQMS) utilizing IoT for improved data collection coverage, cost-effectively interfacing ESP32 microcontroller with sensors and cloud integration, aimed at enhancing data accuracy and public awareness of air pollution.[7]A portable IoT Indoor Air Quality (IAQ) monitoring system with extended battery life, capable of measuring various parameters, calculating air quality indices, and offering user-friendly recommendations for air quality improvement, suitable for large-scale Smart City networks.[8] Smart air quality monitoring and purification system for schools, allowing users to select between air purifiers and natural ventilation based on outdoor and indoor air quality, with noise-reducing fan control, and achieving a 15% error reduction compared to reference instruments in performance evaluation. [9]A wireless sensor network-based indoor air quality monitoring system utilizing Arduino, XBee modules, and micro sensors for real-time data accessibility via web and mobile, effectively assessing and mitigating indoor pollutant exposure risks.[10] A real-time IoT air quality monitoring system utilizing LoRa sensor nodes, Arduino control boards, and cloud integration for comprehensive environmental data collection, accessible to users via a single gateway device, mobile appand cloud website, covering various parameters for large-scale areas.

III. CIRCUIT DIAGRAM

The Arduino Uno is powered by a microcontroller chip, which is the brain of the board. It uses the ATmega328P microcontroller chip from Atmel. This microcontroller runs at 16 MHz and has 32 KB of flash memory for storing the program code, 2 KB of SRAM for data storage and 1 KB of EEPROM for non-volatile data storage. The MQ 135 and Optical dust sensors are linked to the Arduino Uno. The input signal from the sensors is delivered to the Arduino and the LED, buzzer, LCD display receive the output from the arduino. The received output alerts the users through LED, buzzer and the AQI value will be displayed on the LCD display.

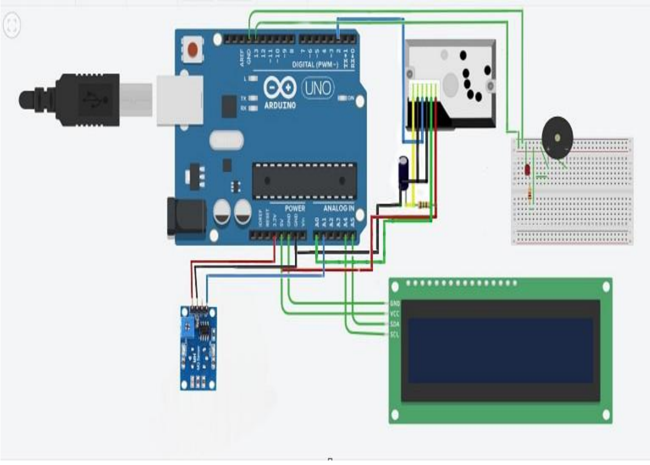

Fig 1.1 Circuit Diagram

IV. HARDWARE SPECIFICATIONS

1. ARDUIO UNO:
The ATmega328P serves as the foundation for the Arduino UNO microcontroller board. It contains 6 analogue inputs, a 16 MHz ceramic resonator, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. A low-cost, adaptable, and simple-to-use programmable microcontroller board called Arduino UNO is available for use in a range of electronic applications.

2. MQ135 SENSOR:
The MQ-135 Gas Sensor can identify dangerous gases and smoke, including ammonia (NH3), sulphur (S), benzene (C6H6), and CO2. The MQ135 sensor operates on the principle of chemoresistance. It contains a sensing element with a sensitive layer that reacts with the target gases.This sensor, like the others in the MQ series of gas sensors, has a pin for both digital and analog output. The digital pin turns high when the amount of these gases in the air exceeds a predetermined threshold.

3. OPTICAL DUST SENSOR:
The GP2Y1010AU0F from Sharp is an optical air quality sensor built to detect dust particles. To enable this device to detect the reflected light of dust in the air, an infrared emitting diode and a phototransistor are diagonally placed. It is frequently employed in air purifier systems and is particularly good at detecting extremely small particles, such as cigarette smoke.

4. PIEZO BUZZER:
Piezo buzzers can be used effectively in air quality monitoring systems to provide audible alerts or warnings based on specific air quality parameters. They can produce high audible outputs from small (milliwatt) input. Incorporating buzzers into this systemenhances user awareness and safety by providing real-time audible notifications when air quality levels exceed predefined thresholds or when potentially harmful pollutants are detected.Buzzers serve as valuable components in air quality

monitoring systems by enhancing situational awareness, promoting safety, and encouraging prompt actions in response to air quality issues. They are an integral part of creating effective and user-friendly air quality monitoring solutions.

5. LED:
In air quality monitoring systems, LEDs (Light-Emitting Diodes) are employed as visual indications. Users can receive clear and simple-to-understand information regarding the state of the air quality from them. Different LEDs are dedicated to specific air quality parameters or pollutants, when a particular pollutant's concentration rises, the corresponding LED change color and blinks. Clear labeling and user-friendly interfaces are key to ensuring that users can interpret the information effectively. Additionally, combining LEDs withother forms of feedback, such as sound alerts and LCD display in this project enhances the overall user experience.

6. LCD DISPLAY:
LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation.A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels. LCDs are made with either a passive matrix or an active matrix display grid. This air quality monitoring system uses a 16x2 display, it is an effective way to provide real-time data visualization and user-friendly feedback. LCD displays can convey air quality information, pollutant concentrations, the air quality index value other relevant data in a clear and easily understandable format.

V. SOFTWARE SPECIFICATIONS

1. ARDUINO IDE:
The software tool Arduino IDE (Integrated Development Environment) is used to programme Arduino boards. It offers a simple and user-friendly writing interface, assembling and sending code to the Arduino microcontroller.Arduino IDE Operating systems include Linux, macOS, and Windows.The IDE's Board Manager enables to maintain the essential board definitions for various Microcontrollers compatible with the Arduino, like Arduino Uno, Arduino Nano, Arduino Mega, and a lot more.

VI. FLOWCHART

Fig. 1.2 is a pictorial representation of the air quality monitoring system thus proposed. To detect any dangerous particles in the ambient air and determine the AQI value, the MQ135 optical dust sensor combined with the Arduino Uno is employed. The alarm mechanism is activated if the AQI value exceeds 50 ppm, which causes the LED to blink, the buzzer to beep, and the LCD display to show the output. The alarm system is switched OFF and the output is displayed in the LCD display if the value is not harmful.

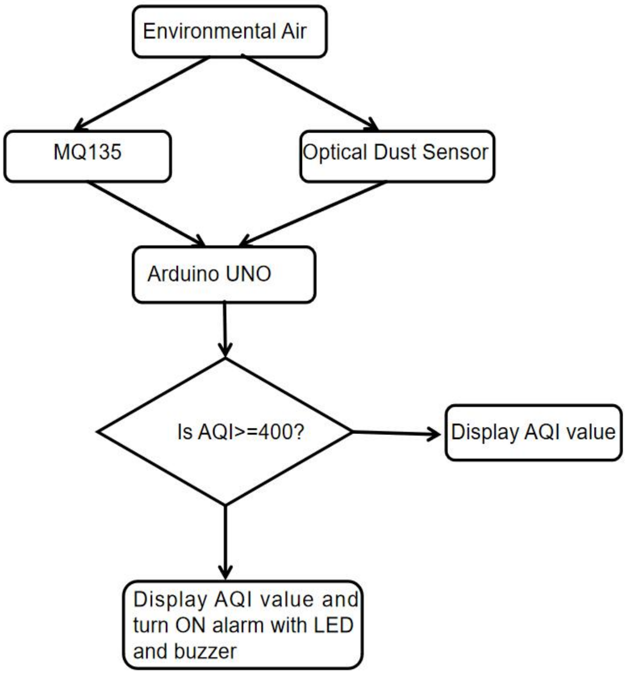

Fig 1.2 Flowchart

VII. HARDWARE RESULTS

In order to test the working of the proposed air quality monitoring system and analyse the data thus collected, the system was experimented in a kitchen (an indoor environment) and was observed at different hours such as while the kitchen was in use and while the kitchen was not in use, for a course of 5 consecutive days. The average values of the survey is represented graphically. The figures given below,Fig. 1.3 and Fig. 1.4, are graphical representation of the output from the sensors at two different instances (while the kitchen in use and not in use).

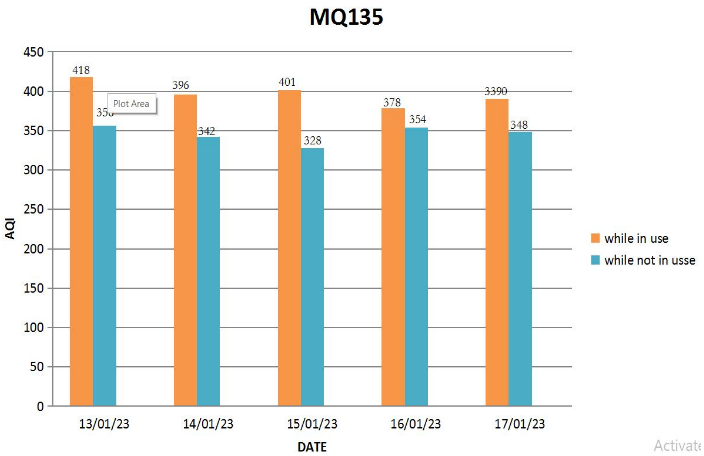

Fig 1.3 Output from MQ135

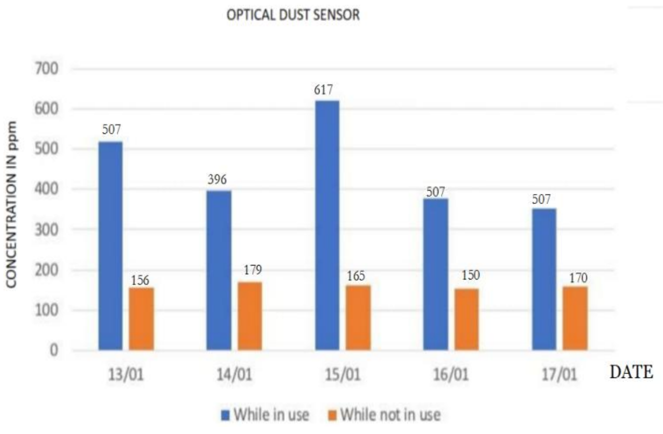

Fig 1.4 Output from Optical dust sensor

The MQ135 gas sensor is used to measure the Air Quality Index (AQI) value in our surrounding. Fig. 1.3 shows the output from MQ135 sensor at different instances. This is the survey barchart for consecutive five days representing the mean value of AQI while in use ranging around 400 ppm to 450 ppm and AQI while not in use ranging around 300 ppm to 350 ppm, where the value should not exceed 400 ppm.

Fig. 1.4 is a survey barchart representing the output from the Optical Dust Sensor (GP2Y1010AUOF). The survey was carried on for five days consecutively. It could be noticed from the graph that the the mean value of the dust sensor in kitchen while in use is around 400 ppm to 620 ppm and when not in use, it is around 150 ppm to 200 ppm where the default value should be lesser then 250 ppm.

VIII. CONCLUSION

People suffer premature deaths annually due to household exposure to particles in home, offices, factories and public buildings. Indoor air quality has a significant negative impact on physical, emotional, and mental well-being.Monitoring air quality is crucial for understanding the environmental impact of various activities and industries. By tracking pollutant levels, we can better regulate emissions and work towards a cleaner, more sustainable future. The "Air Quality Monitoring System" is a trustworthy, preciseand global air monitoring system that is essential in recognising and reducing these deadly health threats. This system's data is essential for identifying and assessing pollution hotspots. The proposed architecture will assist in real-time analysis of the air quality for a specific area and in limiting and reducing environmental pollution.By providing real-time data on air quality, it can help individuals and communities make informed decisions to protect their health. It can also assist local authorities in implementing targeted interventions to reduce exposure to harmful pollutants carbon monoxide emissions and particulate matters suspended in the atmosphere.The initiative to install an air quality monitoring system has the potential to greatly enhance public health, encourage environmental sustainability, and provide useful information for research and government. The knowledge and skills obtained from this initiative will be essential in our ongoing efforts to create a cleaner and healthier environment for everyone as we continue to tackle air quality concerns.

IX. REFERENCES

[1] G. Marques and R. Pitarma, "Health informatics for indoor air quality monitoring," 2016 11th Iberian Conference on Information Systems and Technologies (CISTI), Gran Canaria, Spain, 2016, pp. 1-6, doi: 10.1109/CISTI.2016.7521375.

[2] M. Murad, M. Y. I. Zia and I. A. Tasadduq, "Monitoring Pollution and Air Quality of Pedestrian and Automotive Tunnels in the City of Makkah," 2020 Industrial & Systems Engineering Conference (ISEC), Makkah, Saudi Arabia,2020,pp.1-5,doi:10.1109/ISEC49495.202 0.9229955.

[3] S. Od, H. -H. Huang and J. -B. Wei, "Apply LoRa Technology to Construct an Air Quality Monitoring IoT System," 2021 IEEE 3rd Eurasia Conference on Biomedical Engineering, Healthcare and Sustainability (ECBIOS), Tainan, Taiwan, 2021, pp. 88-91, doi: 10.1109/ECBIOS51820.2021.9510979.

[4] B. Tijani, A. D. Almannaee, A. A. Alharthi and A. M. Alremeithi, "Wireless sensor node for indoor air quality monitoring system," 2018 Advances in Science and Engineering Technology International Conferences (ASET), Dubai, Sharjah, Abu Dhabi, United Arab Emirates,2018,pp.1-6,doi:10.1109/ICASET.2018.83768 39.

[5] S. Zhi, Y. Wei, Z. Cao and C. Hou, "Intelligent controlling of indoor air quality based on remote monitoring platform by considering building environment," 2017 4th International Conference on Systems and Informatics (ICSAI), Hangzhou, China, 2017, pp. 627-631, doi: 10.1109/ICSAI.2017.8248365.

[6] D. Kim, S. Cho, L. Tamil, D. J. Song and S. Seo, "Predicting Asthma Attacks: Effects of Indoor PM Concentrations on Peak Expiratory Flow Rates of Asthmatic Children," in IEEE Access, vol. 8, pp. 8791-8797, 2020, doi: 10.1109/ACCESS.2019.2960551.

[7] C. Y. Chang, S. -J. Guo, S. -S. Hung and Y. -T. Lin, "Performance Analysis of Indoor Smart Environmental Control Factors: Using Temperature to Control the Rate of Formaldehyde Emission," in IEEE Access, vol. 7, pp. 163749-163756,2019,doi10.1109/ACCESS.2019.29501 42.

[8] M. Hussain, S. Aleem, A. Karim, F. Ghazanfar, M. Hai and K. Hussain, "Design of Low Cost, Energy Efficient, IoT Enabled, Air Quality Monitoring System with Cloud Based Data Logging, Analytics and AI," 2020 International Conference on Emerging Trends in Smart Technologies (ICETST), Karachi, Pakistan, 2020, pp. 1-6, doi: 10.1109/ICETST49965.2020.9080705.

[9] P. K. Maduri, R. Nigam and P. Sharma, "Centralized Air Purification System Using Ai," 2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), Greater Noida, India, 2021, pp. 884-888, doi: 10.1109/ICAC3N53548.2021.9725566.

[10] E. Alexandrova and A. Ahmadinia, "Real-Time Intelligent Air Quality Evaluation on a Resource-Constrained Embedded Platform," 2018 IEEE 4th International Conference on Big Data Security on Cloud (BigDataSecurity), IEEE International Conference on High Performance and Smart Computing, (HPSC) and IEEE International Conference on Intelligent Data and Security (IDS), Omaha, NE, USA, 2018, pp. 165-170, doi: 10.1109/BDS/HPSC/IDS18.2018.00045.

[11] A. Srivastava, A. Ahmad, S. Kumar and M. A. Ahmad, "Air Pollution Data and Forecasting Data Monitored through Google Cloud Services by using Artificial Intelligence and Machine Learning," 2022 6th International Conference on Electronics, Communication and Aerospace Technology, Coimbatore, India, 2022, pp. 804-808, doi: 10.1109/ICECA55336.2022.10009293.

[12] M. Afzal, H. A. H. Gondal, M. N. Ullah and S. Akbar, "IoT Based Smart Environmental Monitoring System Using ESP32/We-Mos D1 Mini & ThingSpeak," 2021 International Conference on Innovative Computing (ICIC), Lahore, Pakistan, 2021, pp. 1-6, doi: 10.1109/ICIC53490.2021.9691508.