International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 01 | Jan 2025 www.irjet.net p-ISSN: 2395-0072

GREEN CITY AIOT: INTELLIGENT URBAN AIR QUALITY OPTIMIZATION

**Dr. S. Brindha[*1],Ms. T. Rajeshwari[*2], Mr. N. Balaji[*3], Mr. G. Cyril Samson[*4]
Mr. PL. Krithick[*5], Mr. k. Gokul[*6]**

[*1]*Head Of The Department, Department Of Computer Networking, PSG Polytechnic, Coimbatore, India.*
[*2]*Lecturer, Department Of Computer Networking, PSG Polytechnic College, Coimbatore, India.*
[*3,4,5,6]*UG Students, Department Of Computer Networking, PSG Polytechnic College, Coimbatore, India.*

---***---

Abstract:

Delhi, the capital city of India, is one of the most polluted cities in the world, with air pollution levels frequently exceeding safe limits set by global health organizations. Major sources of air pollution in Delhi include vehicular emissions, industrial activities, construction dust, biomass burning and seasonal weather conditions like thermal inversions. Effective air quality monitoring systems play a pivotal role in addressing this challenge by providing real-time data and analyzing the concentration of pollutants in the atmosphere. Advanced technologies, such as IoT- and sending data to the cloud server via the internet. This abstract highlights the critical role of air quality monitoring systems in developing informed mitigation strategies, raising public awareness, based sensors enhance the accuracy and accessibility of air quality data and provide real-time data and supporting policymaking to reduce pollution levels and improve environmental and human health. Cleaner air enhances overall quality of life and increases life expectancy. These systems leverage advanced sensing technologies, IoT connectivity, and data analytics to provide real-time insights into air quality, identify pollution sources, and evaluate compliance with environmental standards. This abstract underscores the comprehensive advantages of combating air pollution, highlighting the importance of collaborative efforts among governments, industries, and communities to achieve cleaner air and a healthier, more sustainable future. All sensor readings for each post are displayed on the app, and alerts are sent via SMS and the app.

***Key Words*: The Internet of things, Air pollution, Real-time Tracking, Air quality monitoring, Environmental health.**

1. INTRODUCTION

Air pollution is one of the major problems in Delhi, the capital city of India. It has become a severe and persistent environmental and public health crisis. During the winter season it has experienced some of the highest level of air pollution in the world. As a result, residents of Delhi face elevated risks of respiratory diseases, cardiovascular issues, and other health problems. In environmental view residents of Delhi face reduced visibility while driving which has led to frequent accidents; it also causes damage to ecosystems. It also causes economic impact like loss of productivity, healthcare costs, tourism decline, increased energy costs, agriculture losses. Air pollution in Delhi is driven by a variety of factors both natural and human-made like vehicular emissions, industrial pollution, construction dust, crop burning in neighboring states, construction of new infrastructure, use of firecrackers, burning of biomass, weather and geographical factors, waste burning, household emission This paper presents an IOT based solution which collects data through sensors. In this we use IoT sensors to monitor air pollution in the city, it detects the impurities in air and collects data. Reducing air pollution helps to increase the quality of life.

This paper presents an IOT-based solution that is expected to automate air pollution. The system uses IoT sensors to monitor environmental parameters such as temperature, humidity, and air quality in real time. By automating these processes, the system will help increase air quality monitoring system. Improves cleaner air and a healthier life, more sustainable future.

2. REAL-TIME AIR POLLUTION MONITORING

The first aspect of this system is the real-time monitoring of environmental conditions such as temperature, humidity and air quality. Sensors installed throughout the urban, rural, and industrial areas to ensure environmental and public health safety continuously monitor these parameters. and sent to the central processing unit for air quality Gas sensors use harmful gas emissions such as ammonia (NH3), carbon dioxide (CO2), and methane (CH4) benzene (C_6H_6), alcohol (C_2H_5OH), smoke, and other Volatile Organic Compounds (VOCs), these Gas can be sensed by the sensor

The information is reflected on a dashboard where the data can view in real time. If any environmental factors exceed a predetermined threshold an alert will be generated.

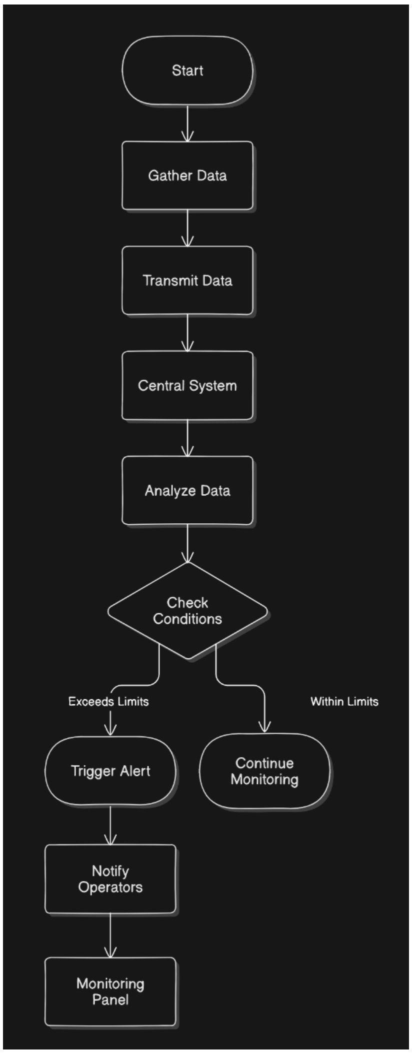

Fig- 1: Data flow

1. The sensor collects temperature, humidity and gas concentration.

2. Data will be sent to a central system for analysis and tracking.

3. An alert will be issued if conditions exceed the ideal limit

3.MOBILE DEVICE-BASED CONTROL MONITORING

This part of the system involves developing a mobile application that allows operators to remotely monitor their environment. The mobile application serves as a user to manage interface that provides real-time information. It allows users to track environmental parameters, and receive alerts from the system. Operators can adjust settings such as humidity, temperature and gas value. Even if it's outside the location. The application also stores historical data to enable trend analysis and better long-term decision making for air pollution. Mobile app resources:

Real-time monitoring: Displays temperature, humidity and air quality information.

Control: Turn specific sensors on or off based on need, remotely adjust sensor sensitivity to maintain accuracy.

Alert system: Immediate notification when limits are violated.

Data Log: History log for data analysis and reporting.

4.SYSTEM ARCHITECTURE

The system architecture is designed to ensure efficient communication and real-time processing between IOT sensors, central processing units, and mobile applications. and dice storage in the cloud Each component plays an important role in the collection, transmission, storage and display of data to support or automate the management of the air pollution.

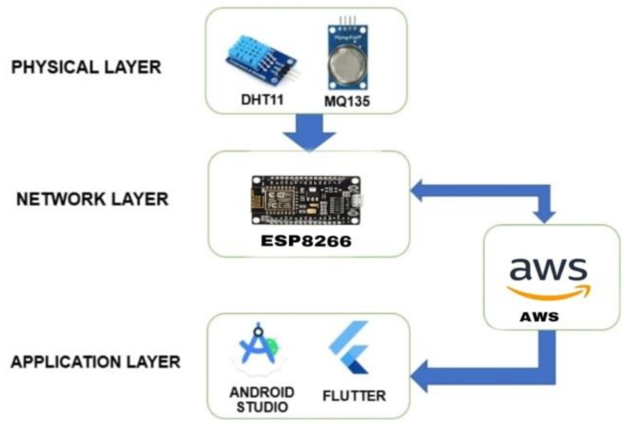

Fig-2: System Architecture

4.1 IOT SENSOR

The AIOT system relies on multiple sensors embedded to continuously monitor environmental parameters. These sensors include:

Temperature sensor: A temperature sensor in an air quality monitoring system helps track environmental conditions that influence pollutant behavior and sensor accuracy. It measures air temperature, which affects how pollutants spread and concentrate. For example, higher temperatures can increase ozone levels or smog formation.

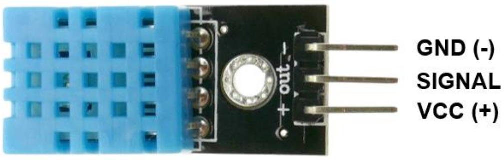

Fig-3:DHT11

Humidity Sensors: Humidity sensors in air quality monitoring systems help track moisture levels in the air, which affect pollutant behavior and sensor accuracy. High or low humidity can influence the size of particulate matter, chemical reactions, and the formation of smog, impacting air quality.

Gas Sensor: Gas sensors like electrochemical, semiconductor, infrared, and optical sensors are used in air pollution monitoring systems to detect harmful gases (e.g., CO, NO_2, VOCs) and particulate matter. They provide real-time data for urban, industrial, and environmental applications. Gas sensors for air quality monitoring detect various harmful gases and pollutants in the air.

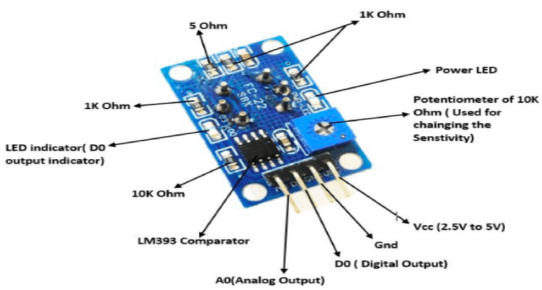

Fig-4:MQ-135

4.2:MICROCONTROLLER /PROCESSOR

The brain of the system hardware is the microcontroller. It processes data collected from IoT sensors for this project. ESP8266 or Arduino microcontrollers are used because of their flexibility. Low power consumption and the ability to read with multiple sensors simultaneously. The microcontroller collects real-time data from two sensors and sends it to

Send notifications to a mobile device as it follows the following steps:

Data collection: The sensor collects environmental data (such as temperature, humidity, gas concentration).

Software and Programming: Programming Environment: Use the Arduino IDE for easy programming and control over the ESP8266.

Data transmission: Using the Wi-Fi module integrated into the microcontroller. The processed data will be sent to data bank (Blynk) for later storage and analysis.

Data Processing: The microcontroller processes the raw sensor data and convert it vision.

Web Dashboard: The system can be connected to a mobile app or a web-based dashboard, where users can monitor real-time data and receive alerts about air quality.

Email or SMS Alerts: The system can send real-time alerts via email or SMS when the air quality crosses critical thresholds. This helps users take immediate actions, like ventilating a room or turning on air purifiers.

4.3 WIRELESS COMMUNICATION (WI-FI)

The wireless communication system for air pollution monitoring involves the use of wireless sensors and communication technologies to detect, collect, and transmit air quality data in the city. Air quality sensors are installed in different locations of the city to measure pollutants and collect data continuously. Sensors send the data to the cloud platform using cellular networks, Wi-Fi, or LPWAN. This data can be accessed by the authorities and public using the dashboard or apps. Wireless communication allows for automated alerts via mobile apps, websites, or SMS, informing residents about air quality levels. Wireless communication enables more effective and scalable air pollution monitoring, helping cities like Delhi tackle their pollution challenges in an efficient manner.

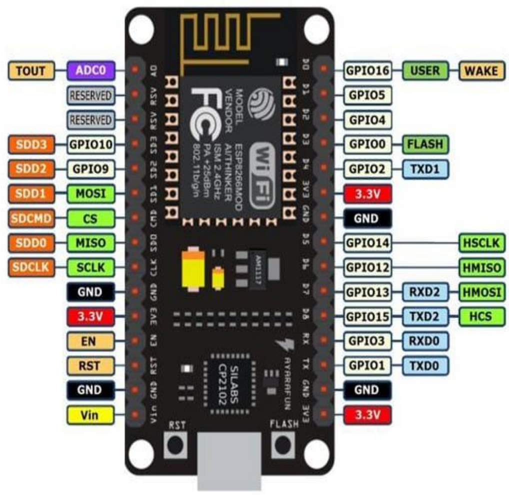

Fig-5:ESP8266 Wi-Fi module

4.4 CLOUD BASED WEAPONS (AWS)

Amazon cloud storage service acts as a back-end data warehouse to store and manage sensor data. This guarantees that the data collected from the sensors is instantly updated in the mobile application. The main benefits of using AWS include:

Scalability: AWS scalability can be effectively applied to air pollution monitoring and management by enabling real-time data collection, processing, and analysis across large-scale environments. Systems can handle increasing users and integrate multiple devices.

Real-time updates: A real-time air pollution monitoring system powered by AWS provides continuous updates, enabling timely actions and insights. Here's how real-time updates can be implemented effectively and allowing operators to receive immediate updates whenever they exceed their limits. A limit or warning has occurred.

Security and data management: critical for air pollution monitoring systems to ensure data integrity, confidentiality, and compliance with regulatory standards. Secures communication between air quality sensors and the cloud using mutual TLS authentication and encryption (AES-256). This ensures that only authorized users can access or edit the data.

(e.g., smoke, industrial emissions). Share data with local authorities or communities.

4.5 MOBILE APPLICATION FOR AIR POLLUTION

Applications developed in Flutter serve as the main interface between farm user and the AIOT system. Flutter was chosen because of its ability to create multi-platform mobile applications. This makes it possible to use the system on Android and iOS devices with a single code base. The main functions of the application include:

Real-time monitoring: This app shows real-time temperature, humidity and gas levels. It is displayed through graphs and an easy-to-read web page and provide global, regional, or local air quality reports using APIs (e.g., Open Weather, AirVisual).

Alarm system: Whenever environmental parameters exceed preset limits. The application will create a notification. To inform user of problems These notifications are sent via push notifications. Serious problems are guaranteed immediately.

Access historical data: The app stores historical data in aws, allowing users to analyze past trends and optimize farm conditions over time.

Data Visualization: Interactive maps showing pollution hotspots.

Community Reporting: Enable users to report pollution incidents

4.6 ALERTING MECHANISMS

Designing an alerting system for air pollution monitoring involves setting up mechanisms to monitor air quality parameters and notifying relevant stakeholders when certain thresholds are exceeded.

Real-Time Alerts: Send immediate notifications when pollutant levels exceed predefined thresholds like SMS, Email, Push Notifications.

Periodic Updates: Provide regular updates on air quality, even if no thresholds are exceeded by a channels like Daily emails or app notification, social media updates.

Escalation Alerts: Triggered for prolonged exposure to high pollution levels or when levels reach "Hazardous." Inform local authorities or emergency response teams.

Public Warnings: Broader alerts through public channels during severe air quality by Radio/TV announcements and Sirens or public address systems.

Mobile Apps: Provide real-time AQI data and alerts. Allow users to set custom thresholds for notifications.

Web Dashboards: Visualize pollution data and alert statuses on interactive maps or charts. Allow access to historical data and trends.

Wearable Devices: Smartwatches or fitness bands with AQI indicators. Vibrations or on-screen alerts for severe conditions.

Smart Home Devices: Trigger air purifiers or close ventilation systems automatically when pollution levels rise.

HVAC Systems: Automatically adjust settings based on indoor and outdoor AQI.

Example Alert Message:

"Unhealthy Air Quality Alert: PM2.5 level is 180 µg/m³ in Downtown. Avoid outdoor activities, especially for sensitive groups. Effective until 6 PM."

4.7 SENSOR MONITORING

Sensor monitoring is the core of an air pollution monitoring system, as it involves collecting, processing, and analyzing data on air quality.

Sensor Placement and Deployment: Urban areas, Industrial Zones, Rural and Remote Areas, Indoor Monitoring.

Sensor Health Monitoring: Track the status of sensors. Use self-diagnostic features to identify malfunctioning units.

Spatial Mapping: Use GIS tools to map pollution levels across different areas. Deploy mobile sensors on vehicles for dynamic monitoring.

User Interface and Reporting: Provide user-friendly dashboards for stakeholders. Generate periodic reports to track progress and inform policy decisions.

Parameter Monitoring: Measure critical pollutants like PM2.5, PM10, CO, NOx, SO2, O3, and VOCs. Monitor auxiliary parameters such as temperature, humidity, and wind speed for better data interpretation.

5. IMPACT OF AIR POLLUTION

5.1 Human Health

Respiratory and Cardiovascular Diseases: Air pollution is a significant contributor to respiratory and cardiovascular diseases. Fine particulate matter (PM2.5), ozone (O_3), nitrogen oxides (NOx), and sulfur dioxide (SO_2) can penetrate deep into the lungs and bloodstream, leading to conditions such as asthma, bronchitis, and even lung cancer.

Premature Mortality: The World Health Organization (WHO) estimates that air pollution is responsible for millions of premature deaths each year globally. Diseases linked to air pollution include stroke, heart disease, lung cancer, and chronic obstructive pulmonary disease (COPD).

Vulnerable Populations: Children, the elderly, and individuals with pre-existing conditions (e.g., asthma) are especially vulnerable to the adverse health impacts of air pollution. Prolonged exposure to poor air quality can stunt lung development in children and accelerate aging in older adults.

Mental Health: Recent studies suggest that exposure to air pollution may also have negative effects on mental health, contributing to cognitive decline, depression, and anxiety.

5.2Environmental Impact

Ecosystem Damage: Air pollution can disrupt ecosystems, harming vegetation and wildlife. Nitrogen oxides (NOx) and sulfur dioxide (SO_2) can contribute to acid rain, which damages soil, water bodies, and plant life.

Reduced Agricultural Productivity: Air pollutants like ozone can affect crop yields, leading to lower food production. Studies have shown that ozone can reduce photosynthesis in plants, particularly affecting sensitive crops like wheat, rice, and corn.

Climate Change: Some pollutants, like carbon dioxide (CO_2) and methane (CH_4), are greenhouse gases that contribute to global warming. Others, like black carbon (soot), contribute to the melting of glaciers and ice caps. Air pollution and climate change are interlinked, creating a vicious cycle of environmental degradation.

5.3 Economic Costs

Healthcare Costs: The healthcare system bears a significant burden due to air pollution-related diseases. Treatment of respiratory diseases, heart conditions, and cancer requires substantial public and private healthcare expenditures.

Loss of Productivity: Poor air quality can reduce worker productivity due to illnesses, absenteeism, and early retirement from chronic health conditions.

Agricultural Losses: The damage to crops and forests due to pollutants can lead to economic losses in agriculture, affecting food security and livelihoods, particularly in developing countries.

Cost of Environmental Cleanup: Governments often need to invest in the restoration of ecosystems damaged by pollution, including cleaning up water bodies and soils affected by acid rain.

5.4 Air Pollution Sources

Transport: The burning of fossil fuels in vehicles is a major source of air pollution, emitting pollutants like carbon monoxide (CO), nitrogen oxides, and particulate matter.

Industry: Factories, power plants, and refineries release a wide range of pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NOx), and volatile organic compounds (VOCs), contributing to smog and acid rain.

Agricultural Activities: Agriculture releases ammonia (NH_3) and methane (CH_4), which are potent air pollutants. Livestock farming and the use of fertilizers are major contributors to air pollution.

Household Activities: The burning of biomass (wood, crop waste, etc.) and household fuels (such as coal and kerosene) can generate indoor air pollution, which is a leading cause of respiratory diseases in developing regions.

5.5Global and Local Perspectives

Urban vs Rural Areas: Urban areas often face higher concentrations of air pollutants due to dense traffic and

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 01 | Jan 2025 www.irjet.net p-ISSN: 2395-0072

industrial activities, whereas rural areas may experience pollution from agricultural practices and biomass burning.

Regional and Global Transport of Pollutants: Air pollution is not confined to one location. Pollutants can travel long distances, crossing borders and affecting neighboring countries. This transboundary pollution requires international cooperation for effective mitigation.

Indoor Air Pollution: Indoor air pollution, often caused by cooking with solid fuels or using chemical-based products, is a major issue in many developing countries, where it can lead to severe health outcomes, especially among women and children.

5.6 Solutions and Mitigation

Regulation and Legislation: Governments around the world have introduced various measures to reduce air pollution, including stricter emission standards, vehicle regulations, and air quality monitoring. The success of policies like the Clean Air Act in the United States and the European Union's air quality standards demonstrates the potential of regulation.

Renewable Energy Transition: Switching to renewable energy sources (solar, wind, hydroelectric) can significantly reduce the emissions from fossil fuels, mitigating air pollution and its associated impacts.

Cleaner Transportation: Promoting electric vehicles, improving fuel efficiency, and expanding public transportation options can help reduce air pollution from the transport sector.

Green Urban Planning: Urban planning that includes green spaces, tree planting, and reduced traffic congestion can help improve air quality in cities, absorbing pollutants and providing cleaner air.

Public Awareness and Education: Raising awareness about the sources and impacts of air pollution can encourage individuals and industries to reduce emissions and adopt more sustainable practices.

Technological Innovations: Advances in pollution control technologies, such as filters and scrubbers, can help reduce the emissions from industrial processes and power plants.

5.7 Case Studies

Delhi, India: One of the most polluted cities globally, Delhi has implemented various measures, including vehicle restrictions and promoting electric vehicles, to address air pollution.

Beijing, China: China's efforts to curb air pollution have included stricter environmental policies and a shift towards cleaner industrial practices, though challenges remain in rural areas and industry.

Los Angeles, USA: As one of the cities with the most stringent air quality standards, Los Angeles has improved air quality over the decades through regulations targeting emissions from vehicles and industrial activities.

Here are sample of last year air quality data:

Month	Average AQI (PM2.5)	Average AQI (PM10)	Major Pollutants	Air Quality Category
January 2024	270	300	PM2.5, NO2	Very Poor
February 2024	250	290	PM2.5, NO2	Very Poor
March 2024	180	220	PM2.5, NO2	Poor
April 2024	150	180	PM2.5, NO2	Moderate
May 2024	120	150	PM2.5, NO2	Moderate
June 2024	90	110	PM2.5, Ozone	Satisfactory
July 2024	80	100	PM2.5, Ozone	Satisfactory
August 2024	100	130	PM2.5, Ozone	Satisfactory
September 2024	140	170	PM2.5, NO2	Moderate
October 2024	230	250	PM2.5, NO2, CO	Poor
November 2024	300	350	PM2.5, NO2, CO	Very Poor
December 2024	280	320	PM2.5, NO2, CO	Very Poor

Fig-6: Air quality data

6. CONTROL MEASURE

To effectively control an air pollution monitoring system, it's essential to ensure the system is not just monitoring but actively aiding in reducing pollution levels.

Calibration and Maintenance: Regular calibration of sensors to ensure accuracy. Periodic maintenance to avoid sensor drift and failures.

Real-Time Alerts and Automated Actions: Develop threshold-based triggers for pollution levels. Automate control actions, such as activating air purifiers or informing authorities.

Quality Assurance/Quality control (QA/QC): Establish standard operating procedures (SOPs) for data collection Cross-check data with reference-grade instruments for quality assurance.

Redundancy: Deploy multiple sensors in critical locations to reduce the risk of data loss or inaccuracies. Integrate data from overlapping sensor networks for enhanced reliability.

7. RESULT AND OBSERVATION

IOT-based systems are deployed in a air pollution monitoring system and found several important results:

Monitoring Accuracy: The system accurately tracks temperature, humidity and gas levels. It provides real-time information to agricultural operators.

Alert system: Alerts are issued immediately when environmental limits are exceeded. This allows for quick corrective action.

Firebase Integration: Using AWS Firebase allows real-time data synchronization and storage. This ensures that operators have access to the latest information at all times. These observations demonstrate the effectiveness of the IOT system in improving pollution survey management through automatic monitoring and control.

User Engagement: High adoption rates for mobile apps with features like live AQI maps, notifications, and health recommendations. Personalized alerts were particularly effective for users in high-risk groups. Increased awareness about air pollution among users.

System Efficiency: IoT-enabled devices provided real-time updates with minimal latency. Cloud integration ensured scalable data handling and processing. Cloud integration ensured scalable data handling and processing.

Environmental and Health Impact: Communities used the data to address pollution sources. Real-time alerts helped reduce health incidents related to poor air quality. Reduced exposure to pollutants for app users, contributing to better public health outcomes.

8. BENEFITS

Cleaner air enhances overall quality of life and increases life expectancy. Environmental benefits include the restoration of ecosystems, improved biodiversity, and reduced greenhouse gas emissions, which mitigate climate change. Economically, addressing air pollution fosters innovation in clean technologies, creates green jobs, and enhances productivity by reducing pollution-related workforce absenteeism. Reducing air pollution in Delhi would not only improve the quality of life for its residents but also contribute to broader environmental and global goals. The impact would ripple through public health, the economy, and the overall sustainability of the city. Reducing air pollution would significantly enhance the health, well-being, and quality of life for Delhi residents, creating a cleaner, safer, and more equitable urban environment. Furthermore, it promotes sustainable urban development and compliance with international environmental standards.

9. SCOPE AND FUTURE IMPROVEMENTS

The IOT system's modular design allows for future improvements, including:

AI in Real-Time Data Analysis: AI-powered analysis enables real-time data processing from multiple sensors and devices, offering accurate air quality readings. Automated anomaly detection helps identify sensor errors or environmental factors affecting data accuracy.

AI-Personalized Health Alerts: AI can send personalized notifications to users (eg, individuals with asthma) based on their health profiles, pollution levels, and location.

AI-Pollution Source Detection: It identifies sources of pollution by analyzing patterns in air quality data by high levels of air pollution areas.

AI-Predictive Analytics: AI algorithms forecast pollution levels based on historical and real-time data, offering early warnings for high-pollution events.

Integration with IoT: AI-enabled IoT devices (smart sensors, air purifiers, HVAC systems) can collaborate autonomously. When high pollution is detected, the system can automatically notify individuals, trigger air purifiers, or adjust ventilation systems in homes, workplaces, and public spaces to reduce exposure.

Blockchain integration: to guarantee transparency and traceability of data. Future versions of the system may incorporate blockchain technology for secure data storage and sharing. This increases the reliability of agricultural operations and provides valuable information on agricultural management practices.

10. CONCLUSION

The introduction of IOT-based air pollution monitoring system has shown significant potential for improving human welfare.The system's ability to continuously monitor its environment. Manage notifications in real time and provide remote access through mobile applications. The air pollution monitoring system is an essential tool for improving environmental health and achieving sustainable urban and industrial growth. It provides real-time data to track pollutant levels, informs policy decisions, and raises public awareness. While technological advancements improve accuracy and efficiency, challenges like data coverage and system maintenance remain. Ultimately, air pollution monitoring system is key are to achieving cleaner air, supporting sustainable development, and mitigating the harmful effects of pollution.

IOT systems are a promising approach to sustainable and efficient air pollution. Its scalability and adaptability make it suitable for air pollution. By providing real-time data, they help inform policies, raise awareness, and guide actions to reduce pollution. Air quality monitoring systems contribute to better environmental policies, healthier communities, and more informed decision-making.

REFERENCES

[1] Sitaram, K.A., Ankush, K.R., Anant, K.N., & Raghunath, B.R., (2018). IoT based smart management of poultry farm and electricity generation. In IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 1-4. IEEE. https://doi.org/10.1109/ICCIC.2018.8782308. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] G. Katare, G. Padihar, and Z. Qureshi, "Challenges in the integration of artificial intelligence and internet of things," International Journal of System and Software Engineering, Vol. 6, No. 2, pp. 10–15, 2018.

[3] U.N. D, U. S, L. Tamilselvan, and S.N. J, "Client Aware Scalable Cloudlet to Augment Edge Computing with Mobile Cloud Migration Service," International Journal of Interactive Mo bile Technologies (iJIM), Vol. 14, No. 12, pp. 165–178, 2020.

[4] Y. Zhang, Q. Chen, G. Liu, W. Shen, and G. Wang, "Environment parameters control based on wireless sensor network in livestock buildings," International Journal of Distributed Sensor Networks, No. 5, pp. 1–7, 2016.

[5]] J. Kalezhi, J. Mbale, and L. Ndovi, "Microcontroller-based monitoring and controlling of environmental conditions in farming," 2018 IEEE PES/IAS PowerAfrica, pp. 284–288, June, 2018.

[6] B. Lufyagila, D. Machuve, and T. Clemen, "IoT-powered system for environmental condi tions monitoring in poultry house: A case of Tanzania," African Journal of Science Tech nology Innovation and Development, Vol. 14, No. 12, pp. 1–12, 2021.

[7] Dr. S. Brindha, Ms. T. Rajeshwari, Ms. Braj Kaviya A.T, Ms. T. Durga Priyadarshini, Ms. V. Samaya, "Data Analytics And Machine Learning In Intelligent Nutrition Systems: Transforming Health And Wellness" International Research Journal of Modernization in Engineering Technology and Science, Volume:06/Issue:01/Jauuary-2024.