JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AIR, WATER POLLUTION SENSING SMART MONITORING

Mr. Jitesh Ashok Zinjal[1], Mr. Sushil Gaikwad[2], Mr. Prathmesh Rothe[3], Mr. Saurabh Mhadse[4],

Prof. Vijay Gupta[5]

[1234]BE. Student, Department of Electronics and Telecommunication, Shivajirao S. Jondhle College of Engg. & Technology, Asangaon, Maharashtra. India

[5]Dept. of Electronics and Telecommunication, Shivajirao S. Jondhle College of Engg. &Technology, Asangaon, Maharashtra. India

Abstract : The rapid urbanization and industrialization have led to severe environmental challenges, notably air and water pollution, threatening human health and ecological balance. In response, this project proposes the design and implementation of an innovative Air and Water Pollution Sensing Smart Monitoring System (AWPSMS). The present manuscript aims to accomplish a critical review of noteworthy contributions and research studies on SEM, that involve monitoring of air quality, water quality and agriculture systems. We designed a system to detect and monitor pollutants in air and water ecosystems accurately. Utilizing a network of strategically placed sensors, the system collects real-time data on various contaminants, including particulate matter, volatile organic compounds in the air, and significant water quality parameters such as turbidity. The system is equipped with a user-friendly interface that provides instant access to pollution readings, historical data, and trend analysis, enabling stakeholders to make informed decisions. Moreover, the system's IoT integration allows for seamless connectivity and remote access, ensuring that environmental agencies, researchers, and the public stay updated with the latest environmental conditions. The core of the system lies in its smart monitoring capabilities, which employ advanced algorithms and machine learning techniques to analyze the data, identify pollution patterns, and predict potential hazardous events. Finally, the framework of robust methods of machine learning; denoising methods and development of suitable standards for wireless sensor networks (WSNs), has been suggest. Through its comprehensive approach, this project aims to contribute to the creation of cleaner and healthier urban environments, fostering sustainability and improving quality of life for present and future generations.

Keywords :- Air pollution, Water pollution, SEM, IoT, Sensors, Machine learning, Smart city

I. INTRODUCTION

In recent years, the escalating levels of air and water pollution have emerged as pressing environmental concerns, particularly in urban areas worldwide. The detrimental effects of pollution on human health, ecosystems, and overall quality of life underscore the urgent need for effective monitoring and mitigation strategies. Traditional monitoring methods often fall short in providing real-time data and comprehensive insights into pollution dynamics, necessitating the development of innovative solutions. In this context , this project aims to develop a comprehensive monitoring system that leverages the latest in sensor technology and data analytics to provide a real-time, accurate assessment of pollution levels in both air and water environments. The advent of the Internet of Things (IoT) has revolutionized the way we collect and analyze environmental data. By embedding advanced sensors into the natural environment, we can gather detailed information on a wide range of pollutants. These sensors are the project's linchpins, capable of detecting fine particulate matter and toxic gases in the air, as well as critical indicators of water quality such as chemical composition, temperature, and clarity. The pollutants originate from diverse sources including vehicular emissions, industrial activities, agricultural runoff, and domestic waste disposal. The cumulative impact of these pollutants poses significant risks to public health, ecosystem integrity, and sustainable development goals. Therefore, there is an imperative to deploy advanced monitoring technologies capable of providing timely and accurate data on pollution levels.

The AWPSMS represents a novel approach to environmental monitoring, leveraging advancements in sensor technologies, IoT platforms, and data analytics. By deploying a network of sensors strategically across urban areas, the system continuously collects real-time data on key air and water quality parameters. These parameters include concentrations of pollutants, turbidity, dissolved oxygen levels, and temperature variations. The integration of wireless communication enables seamless data transmission to a centralized database for storage and analysis. Furthermore, the AWPSMS offers a user-friendly interface accessible to various stakeholders, including government agencies, environmental researchers, and the general public. Through interactive visualization tools, stakeholders can monitor pollution trends, identify hotspots, and assess the effectiveness of pollution control measures. They can track pollution in real-time, receive notifications, and **access historical data for comparative studies.**

However, the true innovation of this project lies not just in data collection but also in its **smart analytical framework**. The system is designed to process large volumes of data through sophisticated algorithms that can identify trends, predict future pollution events, and trigger alerts when pollution levels exceed safe thresholds. This proactive approach to environmental monitoring is pivotal in preventing the adverse effects of pollution on human health and the ecosystem Moreover, the system incorporates machine learning algorithms to predict pollution levels based on historical data and environmental variables. This predictive capability empowers decision-makers to implement proactive interventions for pollution mitigation and management. In summary, the development and implementation of the AWPSMS hold significant promise in advancing environmental sustainability efforts in urban environments. By providing actionable insights into air and water quality dynamics, the system facilitates evidence-based decision-making and fosters collaborative efforts among stakeholders. Ultimately, the integration of cutting-edge technology with environmental monitoring represents a crucial step towards creating cleaner, healthier, and more resilient cities for present and future generation.

II. .REVIEW OF LITERATURE:-

[1] **Advancements in Sensor Technologies for Environmental Monitoring:-**
Smith et al. (2020): Smith et al. provide a comprehensive review of recent advancements in sensor technologies for environmental monitoring applications. They discuss various types of sensors, including electrochemical, optical, and semiconductor sensors, highlighting their advantages and limitations in detecting pollutants in air and water. The authors emphasize the importance of sensor sensitivity, selectivity, and real-time monitoring capabilities for integration into smart monitoring systems.

[2] **IoT Applications in Environmental Monitoring :-**
Jones and Patel (2019): Jones and Patel examine the role of the Internet of Things (IoT) in environmental monitoring, focusing on its applications in urban air and water quality monitoring. They discuss the integration of sensors, communication networks, and data analytics platforms in IoT-based systems, highlighting their potential to facilitate real-time data collection, analysis, and decision-making. The authors present case studies demonstrating the effectiveness of IoT in monitoring environmental parameters and managing pollution.

[3] **Data Analytics Techniques for Pollution Prediction and Management :-**
Gupta et al. (2021): Gupta et al. review data analytics techniques for pollution prediction and management, with a focus on machine learning algorithms and statistical models. They discuss the development of predictive models to forecast pollution levels based on historical data, meteorological factors, and pollutant sources. The authors highlight the importance of data analytics tools in identifying pollution hotspots, trend analysis, and assessing the effectiveness of pollution control measures.

[4] **Integration of Sensor Networks and Cloud Computing for Environmental Monitoring :-**
Wang and Li (2018): Wang and Li examine the integration of sensor networks with cloud computing infrastructure for environmental monitoring applications. They discuss the benefits of cloud-based solutions, including scalable data storage, real-time data processing, and remote access to monitoring systems. The authors present case studies demonstrating the feasibility of deploying sensor networks for air and water quality monitoring, with data transmitted to cloud-based platforms for analysis and visualization.

[5] **Challenges and Opportunities in Smart Monitoring Systems Implementation :-**
Kumar et al. (2019): Kumar et al. explore the challenges and opportunities in implementing smart monitoring systems for air and water pollution. They discuss technical challenges such as sensor calibration, data accuracy, and interoperability issues, as well as regulatory and privacy concerns. The authors highlight the need for interdisciplinary collaboration among researchers, engineers, policymakers, and stakeholders to address these challenges and leverage emerging technologies to enhance smart monitoring systems' capabilities.

III. PROPOSED SYSTEM

1) **System Overview :-** The goal is to create an integrated system that continuously monitors air and water quality. The system collects data from various sensors, processes it, and provides real-time information to users. Key components include the ESP-32 microcontroller, gas sensors (MQ2, MQ9, MQ135), anemometer, turbidity sensor, DS18B20 Temperature Sensor and an LED display.

2) **Sensor Selection:-**
   - **MQ2 Gas Sensor:-** Detects flammable gases (LPG, smoke, alcohol, propane, hydrogen, methane, carbon monoxide). Provides both digital and analog outputs.
   - **MQ9 Gas Sensor :-** Specifically detects carbon monoxide (CO) gas.Analog output proportional to CO concentration.
   - **MQ135 Gas Sensor :-** Detects multiple gases (ammonia, nitrogen oxides, benzene, CO_2). Analog output based on gas concentration.
   - **Anemometer :-** Measures wind speed. Useful for assessing air movement and dispersion of pollutants.

- **Turbidity Sensor :-** Measures water clarity by detecting suspended particles. Indicates water pollution levels.
- **DS18B20 Temperature Sensor:-** Usable temperature range: -55 to 125°C (-67°F to +257°F)
- **ESP-32 Microcontroller** :- Acts as the central processing unit. Collects data from sensors, processes it, and communicates with other components.
- **LED Display :-** Provides visual feedback to users. Displays real-time air and water quality information.

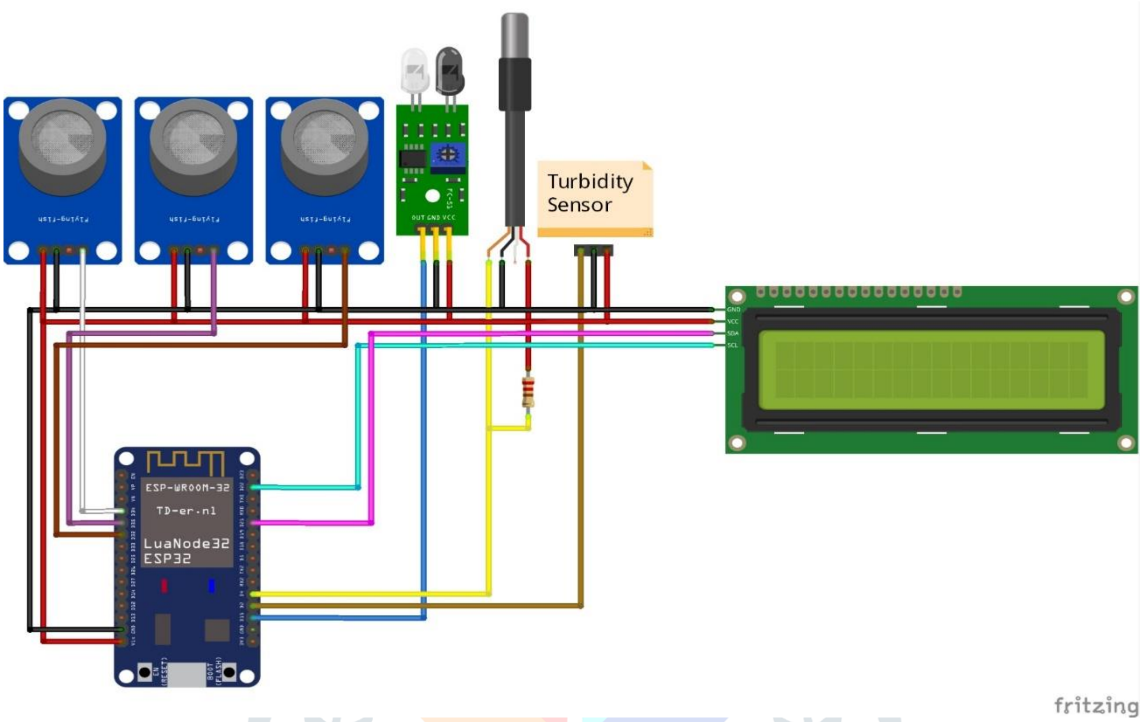

Fig. 1 : Block diagram

IV. WORKING

Here's a brief overview of how a Smart Air and Water Pollution Monitoring System work:

1) **Sensors Placement :-** Install air quality sensors (such as gas sensors, particulate matter sensors, humidity sensors) and water quality sensors (turbidity) at strategic locations. Place air sensors near industrial areas, traffic junctions, and residential zones. Position water sensors in rivers, lakes, and near sewage outlets.
2) **Data Collection: -** The sensors continuously collect data on air and water quality parameters. Air sensors measure pollutants like carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), and particulate matter (PM2.5 and PM10). Water sensors measure pH levels, turbidity, and dissolved oxygen.
3) **Data Transmission:-** We use wireless communication protocols (Wi-Fi) to transmit data from sensors to a central server. Ensure real-time data transmission for immediate analysis.
4) **Data Analysis and Storage :-** Receive data is analyze to calculate air quality indices (AQI) and water quality indices (WQI). . Utilizing ThingSpeak for cloud storage ensures data integrity and accessibility. Use machine learning algorithms to predict pollution trends.
5) **Alerts and Notifications:-** Set threshold values for each parameter (e.g., AQI > 100 indicates poor air quality). If any parameter exceeds the threshold, trigger alerts via SMS, email, or mobile app notifications. Notify relevant authorities and the public about deteriorating air or water quality.
6) **Visualization and Reporting :-** Create a web-based dashboard to visualize real-time data. Display AQI and WQI trends, pollutant concentrations, and historical data. Generate periodic reports for stakeholders and policymakers.
7) **Android Application Development:-** Utilizing Kodular to develop an Android application that interfaces with the ESP32 via Wi-Fi, enabling users to remotely monitor air and water quality parameters.
8) **Mitigation Strategies:-** Based on data analysis, implement corrective measures:-
   i. **For air pollution:** Reduce emissions, improve ventilation, and promote green spaces.
   ii. **For water pollution:** Treat sewage, control industrial discharges, and promote eco-friendly Practices.
9) **Public Awareness:-** Educate the public about pollution levels through mobile apps, websites, and public displays. Encourage citizens to take preventive actions (e.g., using public transport, conserving water).

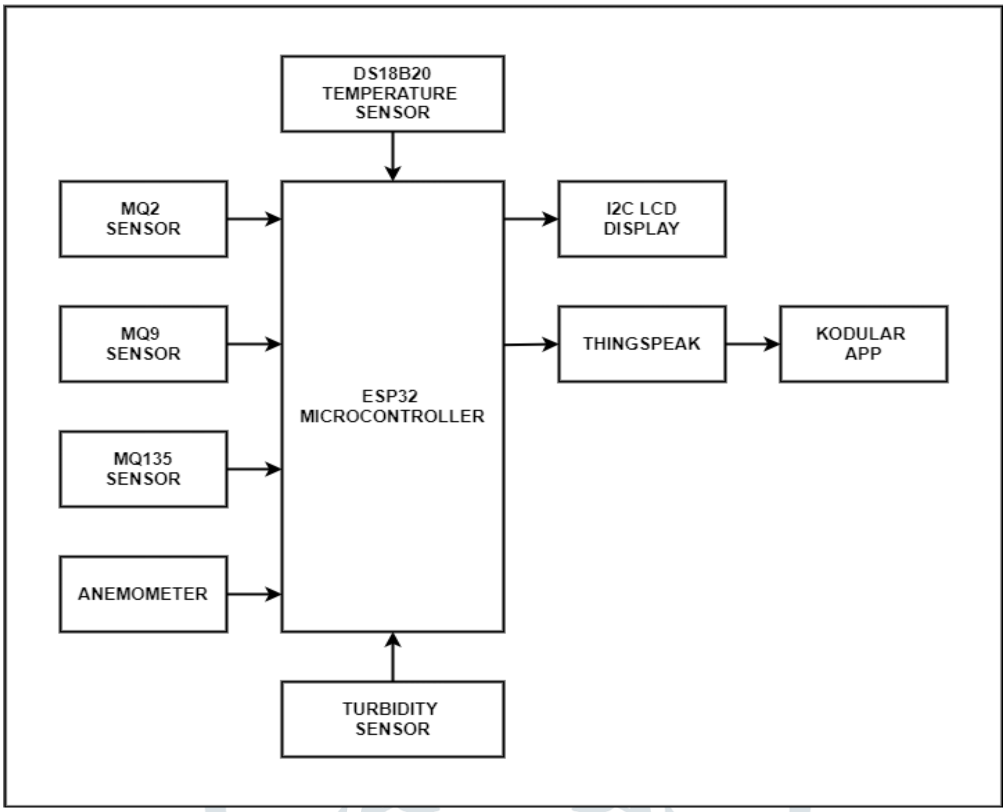

Fig. 2 :- System Architecture (Block Diagram)

V. RESULT

The project successfully developed a comprehensive monitoring system capable of detecting air and water pollution levels in real-time. Utilizing advanced sensor technologies, the system continuously collects data on various pollutants, such as particulate matter, volatile organic compounds and heavy metals. This data is transmitted wirelessly to a central processing unit for analysis and visualization. Users can access the information through a user-friendly interface, allowing for informed decision-making regarding environmental management and public health. Additionally, the system can generate alerts and notifications when pollution levels exceed predetermined thresholds, enabling prompt action to mitigate environmental risks. Overall, the project demonstrates the potential of IoT-based solutions in addressing environmental challenges and promoting sustainable development.

VI. CONCLUSION

Air and water pollution are serious environmental issues that affect the health and well-being of humans and other living organisms. To monitor and control the pollution levels, smart sensor systems based on IoT and machine learning techniques are needed. In this project, we have developed and tested a prototype system that can measure various parameters of air and water quality, such as CO2, smoke, alcohol, benzene, NH3, temperature, turbidity, etc. using MQ135 gas sensor, ESP Wroom 32 , and 16X2 LCD display

The system can also send the data to a web server using WebRTC platform and trigger an alarm when the pollution levels exceed a certain threshold. The system can also predict the future pollution levels using NARX-based hybrid machine learning models. The system has shown promising results in terms of accuracy and reliability in both online and offline analyses. The system can be deployed in various locations and scenarios to provide real-time and smart environment monitoring and management. The system can also be extended with more sensors and features to enhance its functionality and performance.

REFERENCES

[1] Sayed, E.; Ahmed, A.; Yousef, M.E. Internet of things in Smart Environment: Concept, Applications, Challenges, and Future Directions. *World Sci. News* **2019**, *134*, 1–51. [Google Scholar]

[2] Jamil, M.S.; Jamil, M.A.; Mazhar, A.; Ikram, A.; Ahmed, A.; Munawar, U. Smart Environment Monitoring System by Employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities. *Procedia Eng.* **2015**, *107*, 480–484. [Google Scholar] [CrossRef][Green Version]

[3] Bhoomika, K.N.; Deepa, C.; Rashmi, R.K.S. Internet of Things for Environmental Monitoring. *Int. J. Adv. Netw. Appl.* **2016**, 497–501. [**Google Scholar**]

[4] Cicala, L.; Angelino, C.V.; Parrilli, S.; Fiscante, N.; Liberata, S.; Addabbo, P. Unsupervised Post-Fire Assessment of Burned Areas with Free and Open Multispectral Data Using OBIA. 2018, pp. 1–21. Available online: **https://hal.univ-reunion.fr/hal-01957184** (accessed on 17 December 2018).

[5] Gaglio, S.; Re, G.L.; Martorella, G.; Peri, D.; Vassallo, S.D. Development of an IoT Environmental Monitoring Application with a Novel Middleware for Resource Constrained Devices. In Proceedings of the 2nd Conference on Mobile and Information Technologies in Medicine (MobileMed 2014), Prague, Czech Republic, 20–21 October 2014. [**Google Scholar**]

[6] Zhang, D.; Eng, B.; Prof, S.; Connor, N.E.O.; Regan, P.F. Multi-Modal Smart Sensing Network for School of Electronic Engineering. Ph.D. Thesis, Dublin City University, Dublin, Ireland, 2015. [**Google Scholar**]

[7] Tadejko, P. Environmental monitoring systems using internet of things-standards and protocols Pawel Tadejko Environmental policy and management. *Ekon. I Środowisko* **2017**, *4*, 2017. [**Google Scholar**]

[8] Kamal, R. Lesson 11 Internet Connected Environment (Weather, Air Pollution and Forest Fire) Monitoring. 2017, 1–41. Available online: **https://www.dauniv.ac.in/public/frontassets/coursematerial/InternetofThings/IoTCh12L11EnvironmentMonitoring.pdf** (accessed on 6 April 2020).

[9] Air Quality Monitoring Using IoT and Big Data. GSMA 2018. Available online: **https://www.gsma.com/iot/wp-content/uploads/2018/02/iot_clean_air_02_18.pdf** (accessed on 31 May 2020).

[10] Jovanovska, E.M.; Davcev, D. No pollution Smart City Sightseeing Based on WSN Monitoring System. In Proceedings of the 2020 Sixth International Conference on Mobile And Secure Services (MobiSecServ), Miami Beach, FL, USA, 22–23 February 2020; pp. 1–6. [**Google Scholar**]

[11] Arco, E.; Boccardo, P.; Gandino, F.; Lingua, A.; Noardo, F.; Rebaudengo, M. An Integrated Approach for Pollution Monitoring: Smart Acquirement and Smart Information. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.* **2016**, *4*, 67–74. [**Google Scholar**] [**CrossRef**]