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Detection and Real Time Monitoring of Air Using Wemos D1 mini and Android.

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ABSTRACT
Air quality monitoring is essential for assessing the impact of pollutants on human health and the environment. This study presents an innovative approach to air quality monitoring using the NodeMCU ESP8266 development board, which integrates the power of the Internet of Things (IoT) and low-cost sensor technology. The design and implement an air quality monitoring system using the NodeMCU ESP8266 board. The system incorporates sensors for measuring key air pollutants, including particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO2), and ozone (O3) etc. . The collected air quality data is processed using appropriate algorithms to account for sensor drift, temperature compensation, and data normalization. The system's software enables real-time data visualization, allowing users to access air quality information via a user-friendly web interface or mobile application. Field testing is conducted to evaluate the system's performance and assess its accuracy and reliability. The results demonstrate that the NodeMCU-based air quality monitoring system provides reliable and real-time measurements, enabling prompt response to changing air quality conditions. The system's low-cost implementation makes it suitable for deployment in a variety of settings, including urban environments, residential areas, and industrial sites.

Keywords: Internet of Things, Air Pollution, Arduino , Sensors, Arduino IDE

1. INTRODUCTION

Wireless sensor networks (WSNs) have a profound impact on our daily lives. These networks consist of sensor nodes capable of detecting various factors like air pressure, air composition, and water quality. WSNs find applications in diverse settings such as personal spaces, industries, agriculture, home utility monitoring systems, factory automation, automotive, and more. These networks are closely related to the concept of the Internet of Things (IoT), where interconnected devices transmit data through distributed sensor networks.

IoT has found practical use in the medical field, where devices like smartphones and sensing systems can be interconnected to form an infrastructure that grants access to healthcare information and services. This integration is known as "Mobile-Health," a term that reflects the merging of wireless communication systems, WSNs, and global computing tools. In essence, the

emergence of Mobile-Health is a result of the convergence of these technologies, presenting new possibilities for improving healthcare services and monitoring in a connected world. [1]
Air pollution is a pervasive issue affecting every nation, regardless of its level of development. The emission of harmful gases poses significant health risks to both humans and animals, leading to conditions such as lung cancer, eye irritation, and respiratory difficulties. Additionally, pollution can cause mild allergic reactions and more severe ailments like bronchitis, heart diseases, pneumonia, and aggravated asthma. The root of these problems often lies in industries failing to adhere to government regulations and take appropriate measures to reduce gas emissions. Particularly in urban areas of developing countries, health problems are on the rise due to rapid industrialization and the increasing number of vehicles, leading to the release of gaseous pollutants.

To address this critical issue, the proposed work focuses on efficiently, reliably, and accurately monitoring pollution levels around manufacturing industries. By detecting harmful gases present in the vicinity, the system can gauge pollution levels and compare them with standard thresholds. When pollution exceeds safe levels, it sends notifications to alert humans of potential health hazards. The existing system utilizes an Arduino controller, along with three sensors, MQ2, MQ7 and MQ135, and an LCD for displaying data. With advancements in technology, the development of affordable and compact sensors has become both technically and economically viable. The primary focus of the IoT Air Pollution Monitoring System is to track pollution levels, a pressing concern in today's world. Maintaining and monitoring air quality is crucial for a healthier future and improved well-being for all.

The rising popularity of the Internet of Things (IoT) can be attributed to its flexibility and low-cost nature, making it an ideal solution for tackling various environmental challenges, including air pollution monitoring. By employing IoT technologies, we can work towards creating a cleaner and safer environment for everyone.

IOT: IoT is a dynamic and transformative technology that connects the physical and digital worlds, revolutionizing industries and empowering individuals with data-driven insights and efficiency.
Arduino: Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller board and a development environment that allows users to program and control various electronic projects. Arduino is widely used by hobbyists, students, and professionals for prototyping, creating interactive devices, and building electronic projects. Its versatility, affordability, and extensive community support make it a popular choice for individuals interested in electronics and programming.
Sensor: A sensor is a device or instrument that detects and measures physical properties or changes in the environment. It converts these physical stimuli, such as light, temperature,

pressure, humidity, motion, or sound, into electrical signals or data that can be interpreted by electronic circuits or systems. Sensors play a crucial role in various applications, from everyday devices like smartphones and smart appliances to advanced systems in industries, healthcare, automotive, and more. They provide valuable data for monitoring, control, and automation, making them essential components in modern technology and IoT ecosystems.

Firebase: Firebase Database for Arduino is a platform that allows Arduino developers to integrate and store data in a cloud-hosted, real-time NoSQL database provided by Firebase. With this integration, Arduino-based projects can easily send and receive data to and from the cloud, enabling real-time synchronization and data storage. This capability enables developers to build IoT applications, sensor monitoring systems, and other projects where cloud connectivity and real-time data management are essential. Firebase's simplicity and scalability make it a popular choice for Arduino developers looking to extend their projects to the cloud without the need for complex server setups.

1.1 NEED OF MONITORING AIR POLLUTION:

Air pollution monitoring is a crucial undertaking driven by the pressing need to safeguard public health, protect the environment, and promote sustainable living. The quality of the air we breathe profoundly impacts our well-being, with air pollution being a significant risk factor for respiratory and cardiovascular diseases. Regular monitoring of air pollution levels is essential to identify areas with elevated pollutant concentrations, enabling authorities to implement targeted interventions and mitigate health risks for vulnerable populations. Compliance with air quality standards and regulations is another fundamental reason for air pollution monitoring. Governments and environmental agencies worldwide have set specific limits for various pollutants to minimize their harmful effects on both human health and the environment. Continuous monitoring ensures that industries and entities adhere to these standards, leading to better environmental protection and reduced health risks for communities [2]. Understanding the sources of air pollution is equally critical in devising effective pollution control strategies. Monitoring helps pinpoint specific pollution contributors, such as industrial emissions, vehicular traffic, or natural events like wildfires. Armed with this knowledge, policymakers can formulate targeted measures to reduce pollution in problem areas and promote sustainable practices.

Air pollution monitoring also serves as an early warning system, allowing for timely responses to pollution spikes. When pollution levels exceed safe limits, authorities can issue alerts and advisories, enabling the public to take precautionary measures and protect their health. Moreover, assessing the impact of air pollution on climate change is a significant aspect of monitoring efforts. Certain air pollutants, such as greenhouse gases, contribute to global warming and climate disruptions. Monitoring these gases aids in understanding their influence on climate patterns and devising mitigation strategies to combat climate change[14].

Beyond public health and environmental concerns, air pollution monitoring supports research and studies on pollution's long-term effects. Researchers and scientists rely on air quality data to gain insights into the complex interactions between pollutants and their consequences on human health, ecosystems, and the environment [11] .

Promoting public awareness and education about air quality is yet another vital role of monitoring efforts. Transparent and accessible data empowers individuals and communities to adopt cleaner practices, advocate for cleaner policies, and actively participate in collective efforts to improve air quality.

In essence, air pollution monitoring is a multi-faceted endeavor that aids in public health protection, regulatory compliance, pollution source identification, climate change assessment, policy development, research, and raising public awareness. By working together to monitor and address air pollution, we take significant steps towards creating a cleaner, healthier, and sustainable future for all.

2. LITERATURE REVIEW

The "Smart-Air" IoT-based indoor air quality monitoring platform offers real-time monitoring and data transmission to a web server. The device uses IoT technology, including a microcontroller, sensors, and an LTE modem, to measure key air quality parameters like aerosol, VOCs, CO, CO2, temperature, and humidity. Cloud computing handles data storage and analysis. Users can access the web interface remotely to visualize current and historical air quality data, empowering them to take timely actions for healthier indoor environments. The comprehensive pollutant detection sensors ensure a holistic view of indoor air quality for informed decision-making[3].

The proposed framework consists of two components: the Mobile-DAQ unit and the Pollution-Server. The Mobile-DAQ unit includes a microcontroller, pollution sensors, and a GPS device. It measures air pollution levels (CO, NO2, and SO2) and combines them with GPS location, time, and date. The data is then sent to the Pollution-Server using ZigBee technology, which has a lower transmission rate compared to WiFi. The Pollution-Server is a powerful computer application server with internet connectivity, responsible for receiving and processing the data from the Mobile-DAQ unit[4].

The paper introduces a low-cost georeferenced air-pollution measurement system designed as an early warning tool. The system comprises a Mobile-DAQ unit with pollution sensors, a microcontroller, and a GPS device, as well as a Pollution-Server with internet connectivity. The Mobile-DAQ unit collects air pollution data (CO, NO2, SO2) along with GPS location and timestamps. The data is transmitted to the Pollution-Server using ZigBee technology. The system aims to provide an affordable and efficient solution for monitoring air quality and issuing early warnings for potential pollution issues[5].

The paper presents an IoT-based system for monitoring noise and air pollution using a Raspberry Pi. The system utilizes various sensors to measure noise levels and air pollutants. Raspberry Pi serves as the central control unit, collecting data from the sensors. The data is then transmitted to a web server via the Internet, enabling remote monitoring and real-time access to pollution information. The system offers an innovative and cost-effective approach to monitor environmental pollution, aiding in better understanding and management of noise and air quality[6].

The paper "Design and Simulation of a Smart Automated Traffic System in a Campus Community" focuses on creating an intelligent and automated traffic system for a campus community. The system aims to optimize traffic flow, enhance safety, and reduce congestion within the campus area. The research utilizes various emerging technologies to develop the smart traffic system, and the design is simulated for evaluation. The paper provides insights into the proposed system's architecture, functionality, and simulation results. It was published in the International Journal of Emerging Technologies and Innovative Research in 2018, and the full paper can be accessed at the provided URL[8].

3. METHODOLOGY

3.1 Working Principle of Proposed Model

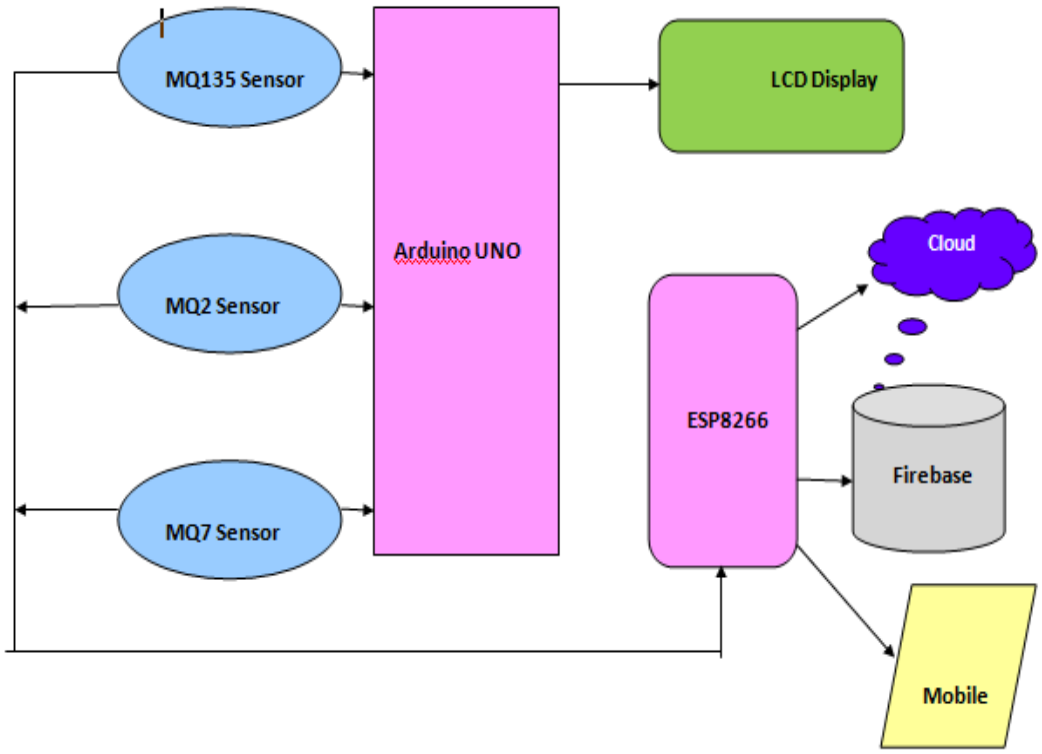

Figure: Block Diagram of Air Pollution Monitoring System

3.2 Air pollution monitoring equipment

3.2.1 Arduino Uno R3 microcontroller

The Arduino Uno R3 is a widely used microcontroller board known for its ease of use and versatility in electronics and robotics projects. Based on the Atmega328P microcontroller, it has digital and analog pins for interacting with sensors and actuators. The built-in USB communication simplifies programming, and it is compatible with the user-friendly Arduino IDE. With extensive community support, it is popular among hobbyists, educators, and professionals, enabling the creation of diverse projects, from simple LED circuits to advanced robots and automation systems.

3.2.2 ESP8266 Wi-Fi Module

The ESP8266 Wi-Fi module is a widely used wireless communication module in IoT projects. It is known for its low cost, small size, and excellent Wi-Fi capabilities. The module includes a microcontroller and built-in Wi-Fi chip, enabling it to connect to Wi-Fi networks and act as both a client and an access point. It is programmable and supports various development platforms, making it accessible to developers. Its versatility has led to its adoption in home automation, smart devices, weather stations, remote sensing, and other IoT applications due to its low power consumption and affordability.

3.2.3 MQ-135 gas Sensor

The MQ-135 gas sensor is widely used to detect various gases in the environment, particularly pollutants like ammonia, nitrogen oxides, and benzene. It operates by a chemical reaction with the sensing material, causing changes in resistance, which are then converted into electrical signals for analysis. The sensor's versatility makes it suitable for air quality monitoring, indoor air pollution detection, and industrial safety applications. However, regular calibration and maintenance are essential for accurate and reliable performance, and its sensitivity to different gases may require specific calibrations depending on the intended use.

3.2.4 MQ-2 Smoke Sensor

The MQ-2 smoke sensor is widely used in smoke detectors and fire alarm systems to detect various gases, including smoke. It operates through a chemical reaction with target gases, causing resistance changes that are converted into electrical signals. Its sensitivity to combustible gases makes it suitable for diverse applications, but proper calibration and maintenance are necessary for accurate performance. However, it's essential to note that while effective in detecting smoke and combustible gases, it responds to other gases as well. Thus, it's often used in conjunction with other sensors for dedicated smoke detection.

3.2.5 MQ-7 Sensor

The MQ-7 sensor is commonly used to detect carbon monoxide (CO) gas in various settings such as industrial, residential, and automotive applications. It operates by detecting CO through a chemical reaction with the sensor's sensitive material, resulting in changes in resistance that are converted into an electrical signal. Due to its high sensitivity, the sensor can detect low levels of CO, making it valuable for early warning and safety systems. However, proper calibration and maintenance are crucial to ensure accurate and reliable readings over time.

4. **RESULTS AND DISCUSSION**

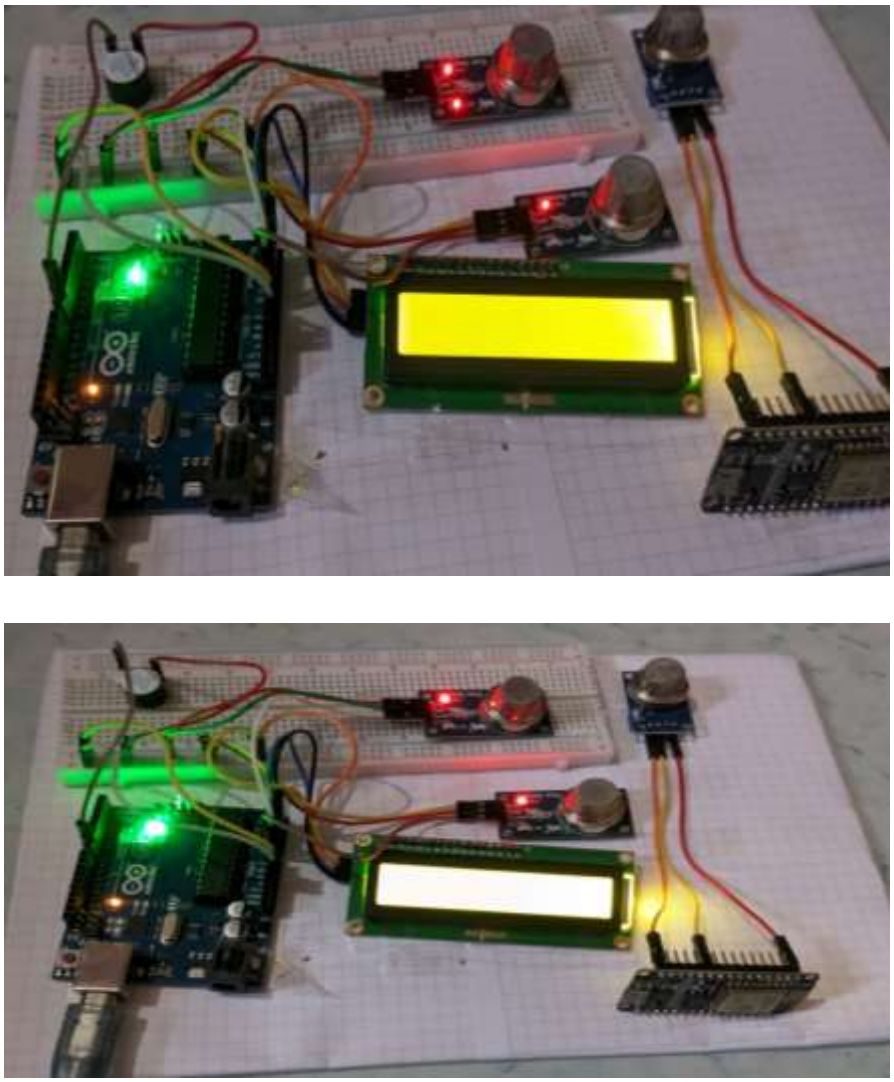

Fig 4.1: Hardware implementation/ Device Setup of Proposed System

Sensors	**Types of Gas Detected**	**Excepted Range**	**Experiment**

			Result
MQ2	LPG, butane, propane, methane, alcohol, and hydrogen	0-1000(Normal) 1000-15000(Risky) 15000-50000(Very high)	410 ppm
MQ7	carbon monoxid	0-100(No effect) 100-800(Risky) 800-1500(Very high)	902 ppm
MQ135	ammonia (NH3), nitrogen oxides (NOx), benzene (C6H6), and other harmful gases	0-500(Normal) 500-1500(Risky) 1500-2000(Very high)	1238 ppm

Table 4.1: Result of Sensor value

5. CONCLUSION

The increasing pollution levels due to industrial and automobile growth and the development of chemical industries. To address this issue and protect humans and the environment, an air pollution monitoring kit was developed. The kit, integrated with a mobile application (IoT), helps users detect, monitor, and test air pollution in a specific area. It also predicts pollution levels along a user's route and offers features like real-time air quality indices. The air pollution monitoring system that utilizes an ESP8266 microcontroller, and Arduino. The system incorporates MQ135, MQ2, MQ7 sensors to monitor air pollution and detect toxic gases in the surrounding environment. The microcontroller controls the entire process, and a Wi-Fi module connects the system to the firebase database for data visualization. An LCD provides visual output in offline mode. The system can help raise awareness about air quality and prompt appropriate actions when pollution levels drop. Additionally, the system can be expanded with additional sensors to monitor more harmful gases in highly polluted areas, contributing to the innovation of new pollution mitigation practices.

6. REFERENCES

[1] U. Varshney, Pervasive healthcare computing: EMR/EHR, wireless and health monitoring. Springer Science & Business Media, 2009.
[2] Arushi Singh, Divya Pathak, Prachi Pandit, Shruti Patil, Prof. Priti . C. Golar, IOT based Air and Sound Pollution Monitoring System, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2017.
[3] H. Ali, J. K. Soe, and S.R. Weller, "A real-time ambient air quality monitoring wireless sensor network for schools in smart cities" In the ICSETS 2019 176 Proceedings of the IEEE First International Smart Cities Conference (ISC2'15). 25-28 Oct. 2015 Guadalajara, Mexico

[4] Mr.Vasim K. Ustad , Prof.A.S.Mali , Mr.Suhas S.Kibile- “Zigbee Based Wireless Air Pollution Monitoring System Using Low Costand Energy Efficient Sensors”, 2014 International Journal of Engineering Trends and Technology (IJETT)
[5] David Marquez-Viloria, J. S. Botero-Valencia, Juan Villegas- Ceballos, A low cost georeferenced air-pollution measurement system used as early warning tool, 2016 XXI Symposium on SignalProcessing,Images and Artificial Vision (STSIVA), pp. 1-6
[6] Uppugunduru Anil Kumar , G Keerthi, G sumalatha, M. Sushma Reddy, "iot based noise and air pollution monitoring system using raspberry pi," 2017.
[7] Matthews V.O., Uzairue S.I., Noma-Osaghae E., and Nwukor F., Design and Simulation of a Smart Automated Traffic System in a Campus Community.", International Journal of Emerging Technologies and Innovative Research (www.jetir.org | UGC and issn Approved), ISSN:2349-5162, 5 (8), 2018, pp. 492-497, Available at :http://www.jetir.org/papers/JETIR1807794.pdf.
[8] Xiaojun, C., Xianpeng, L. and Peng, X., 2015, January. IOT-based air pollution monitoring and forecasting system. In Computer and Computational Sciences (ICCCS), 2015 International Conference on (pp. 257-260). IEEE
[9] Kadri, A., Yaacoub, E., Mushtaha, M. and Abu-Dayya, A., 2013, February. Wireless sensor network for real-time air pollution monitoring. In Communications, Signal Processing, and their Applications (ICCSPA), 2013 1st International Conference on (pp. 1-5). IEEE.
[10] Kavi K. Khedo, Rajiv Perseedoss and Avinash Mungur, "A Wireless Sensor Network Air Pollution Monitoring System," International Journal of Wireless & Mobile Networks, 2(2), 2010.
[11] Nayak, R., Panigrahy, M.R., Rai, V.K. and Rao, T.A., 2017. IoT Based Air Pollution Monitoring System. Imperial Journal of Interdisciplinary Research, 3(4).
[12] Saha, D., Shinde, M. and Thadeshwar, S., 2017, March. IoT based air quality monitoring system using wireless sensors deployed in public bus services. In Proceedings of the Second International Conference on Internet of things and Cloud Computing (p. 87)
[13] Arun Raj V., Priya R.M.P., and Meenakshi, V., "Air Pollution Monitoring In Urban Area," International Journal of Electronics and Communication Engineering , 2017 .
[14] Priyanka, V., "Review: Air Quality Monitoring System," International Journal of Advanced Research in Computer and Communication Engineering, 5(6), 2016.
[15] Snyder, E.G., Watkins, T.H., Solomon, P.A., Thoma, E.D., Williams, R.W., Hagler, G.S., Shelow, D., Hindin, D.A., Kilaru, V.J. and Preuss, P.W., 2013. The changing paradigm of air pollution monitoring.
[16] Dhas, Y.J. and Jeyanthi, P., Environmental Pollution Monitoring System Using Internet of Things (IoT). Journal of Chemical and Pharmaceutical Sciences, 2017.