IOT Air and Sound Monitoring System

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***Abstract*— Noise pollution, posing a substantial environmental hazard to human health both directly and indirectly, is characterized as undesirable or harmful outdoor sound, primarily attributed to road traffic. This pervasive pollutant results from transportation and industrial activities across land, air, waterways, and oceans, adversely affecting the health and well-being of both humans and wildlife. The aim of this project is to enhance and democratize pollution monitoring by leveraging IoT. This solution, stemming from the convergence of computer science and electronics, incorporates the Internet of Things (IoT). The project employs sensing devices connected to an embedded computing system to track fluctuations in parameters such as noise and air pollution levels from their baseline. In our rapidly advancing technological landscape, accessing information about surrounding weather conditions becomes seamless within this interconnected internet environment. The IoT-based project operates on a private channel, connecting all devices in this burgeoning field.**

Keywords—Arduino Uno, Gas Sensor MQ135, Sound Sensor E-35, WIFI Module

I. Introduction

Preserving and enhancing air quality along with keeping check of noise pollution are the fundamental goals of this project. While human activities contribute to global pollution, their impact is relatively smaller than natural sources. Any significant alteration in the atmosphere directly affects its ability to fulfil essential functions. The proposed air quality pollution monitoring system utilizes sensors to measure various pollutants like air quality index and sound values, etc. These sensors communicate with a microcontroller, which processes the data and transmits it over the internet through IoT. This system enables real-time monitoring of air quality in specific areas, allowing authorities to take prompt actions to address pollution issues. Understanding weather conditions is crucial in addressing atmospheric problems. Accurate knowledge of weather patterns helps in assessing and managing issues related to air quality and other environmental concerns. The project is designed to benefit modern society by leveraging the growing use of the internet, particularly through the Internet of Things (IoT). IoT involves interconnected devices embedded with sensors, software, and network connectivity, enabling them to collect and exchange data. It serves as an architectural framework facilitating data exchange and integration between computer systems and the physical world over existing network infrastructure. When equipped with sensors and actuators, IoT becomes part of the broader category of cyber-physical systems, encompassing technologies like intelligent transportation, smart grids, smart homes, and smart cities. Addressing the pressing issues of air and sound pollution, there's a proposal for an integrated monitoring system. This system employs air sensors to detect harmful gasses, transmitting real-time data to a microcontroller. Simultaneously, it measures sound levels, reporting the information to an online server via IoT. Authorities can utilize this data to monitor air quality and noise pollution in various areas, enabling swift actions. Looking ahead, IoT holds potential for diverse consumer applications, from safety warnings to smart home functionalities, emphasizing its role in shaping a healthier and connected future.

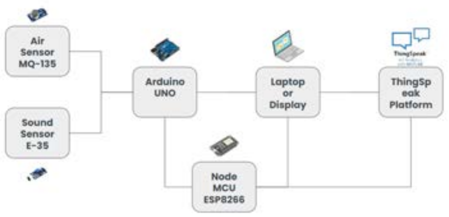

Figure 1

II. Overview

Introducing an innovative IoT-based Air and Sound Monitoring System that utilizes cutting-edge technology components, including gas sensors, sound sensors, a WIFI module, and Arduino Uno microcontroller. The system is designed to provide comprehensive environmental data in real-time. Gas sensors measure critical air quality parameters such as particulate matter, carbon dioxide, sulphur dioxide, nitrogen dioxide, and ozone, while the sound sensor captures ambient noise levels. The Arduino Uno acts as the central processing unit, collecting, and processing data from the sensors. The WIFI module ensures seamless connectivity to transmit data to the cloud platform, Think Speak. This integration with Think Speak allows for remote monitoring, storage, and analysis of environmental data. Users can access a user-friendly dashboard on Think Speak to visualize air quality and sound levels, receive timely alerts, and analyse historical trends. This IoT-based solution serves diverse applications, from urban planning to public health, offering a holistic approach to environmental monitoring and fostering a sustainable future.

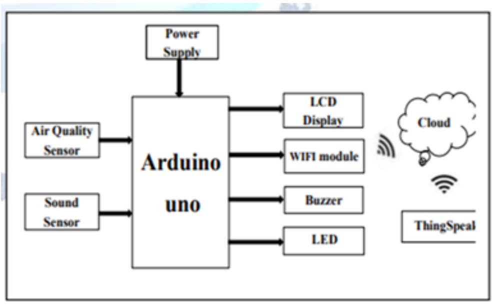

Figure 2

III. Methodology

A. Model

The model employed in our methodology for the IoT-based Air and Sound Monitoring System is centred around a straightforward data acquisition and processing architecture. At its core, an Arduino Uno microcontroller serves as the central processing unit, interfacing with gas sensors, sound sensors, and a WIFI module. The Arduino Uno collects raw sensor data and employs predefined algorithms for signal processing and calibration. These algorithms are tailored to convert analog sensor readings into meaningful and accurate measurements of air quality parameters and ambient noise levels. The gas sensors are calibrated to measure specific pollutants such as particulate matter, carbon dioxide, sulphur dioxide, nitrogen dioxide, and ozone. Simultaneously, the sound sensor captures ambient noise levels in decibels. The Arduino Uno processes this data, ensuring synchronization and time-stamping before transmitting it to the cloud platform, Think Speak, via the integrated WIFI module. The simplicity of the model lies in its reliance on predefined algorithms and straightforward signal processing, making it a cost-effective and accessible solution for real-time environmental monitoring. This model, although uncomplicated, provides valuable insights into air quality and sound levels, making it an ideal choice for various applications, from urban planning to public health.

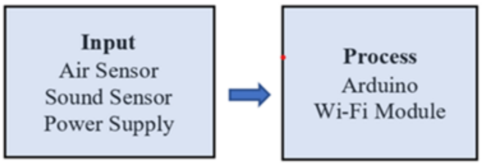

Figure 3

B. Working

The IoT-based Air and Sound Monitoring System comprises several key components, each playing a crucial role in the collective and individual functioning of the project. At the heart of the system is the Arduino Uno microcontroller, acting as the central processing unit. This microcontroller interfaces with gas sensors and a sound sensor, individually calibrated to measure specific environmental parameters. The gas sensors monitor particulate matter, carbon dioxide, sulfur dioxide, nitrogen dioxide, and ozone levels, while the sound sensor captures ambient noise in decibels. The gas sensors and sound sensor provide raw data, which the Arduino Uno processes using predefined algorithms. These algorithms are designed for calibration and signal conversion, ensuring that the collected data is accurate and meaningful. Additionally, the microcontroller handles synchronization and time-stamping of the data, critical for maintaining precision in real-time monitoring. Individually, the gas sensors and sound sensor contribute to the accurate measurement of air quality and ambient noise, respectively. The WIFI module integrated into the Arduino Uno facilitates connectivity and communication. It establishes a wireless link with the Think Speak cloud platform, enabling the seamless transmission of processed data for remote monitoring and storage. On the cloud platform, the data is organized and made accessible for analysis, creating a comprehensive and user-friendly interface. Collectively, the components work together seamlessly, with the Arduino Uno orchestrating the integration of sensor data and the WIFI module enabling real-time communication with the cloud, ensuring the project's overall effectiveness in providing valuable insights into air quality and sound levels.

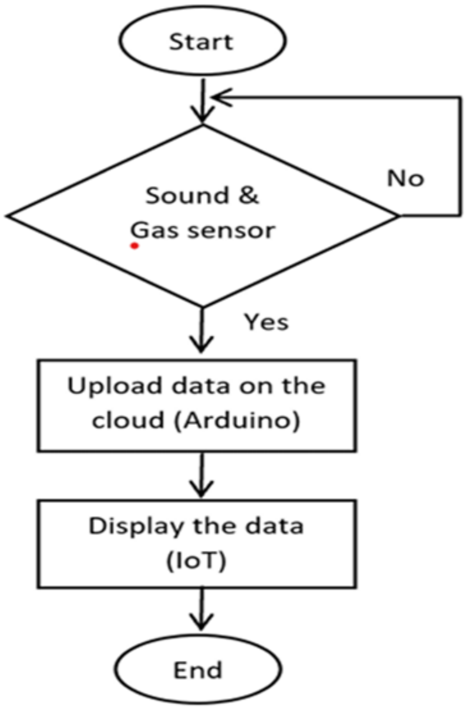

Figure 4

C. Components

- Sensors:
  Dust Sensor (MQ135)
  Smoke Sensor (M-35)
- Microcontroller and Connectivity:
  Arduino Uno
  Wi-Fi Modem (ESP8266)
- Output and Display:
  LED’s
- Power & Connection Components:
  Breadboard
  Pins

D. Components Explained

1. Sensors:

- Dust Sensor (MQ135): The MQ135 Dust Sensor operates on the principle of chemoreceptive changes, where gas absorption alters the sensor's resistance. It necessitates a 5V DC power supply and consumes approximately 150mA during operation. The sensor's sensitivity and accuracy are influenced by temperature and humidity, requiring meticulous calibration for precise environmental monitoring.

Figure 5

- Smoke Sensor (M-35): Utilizing light scattering, the M-35 Smoke Sensor translates changes in light intensity caused by smoke particles into an electrical signal. Operating on a 5V DC power supply with a consumption of around 20mA, the sensor's performance is subject to ambient conditions and requires meticulous calibration for optimal accuracy.

Figure 6

2. Microcontroller and Connectivity:

- Arduino Uno: As the primary computational unit, the Arduino Uno executes predefined algorithms for sensor signal processing. It operates on a 5V DC power supply with a typical current consumption of approximately 50mA. The microcontroller's computational efficiency and power consumption are critical considerations in the context of real-time data processing and transmission.

Figure 7

- Wi-Fi Modem (ESP8266): The ESP8266 Wi-Fi module, an integral component for remote data transmission, operates on a 3.3V DC power supply and consumes around 80mA during transmission. Its impact on power consumption and data transfer rates is crucial for evaluating the system's overall energy efficiency and communication robustness.

Figure 8

3. Output and Display:

- LEDs: Serving as visual indicators, Light Emitting Diodes exhibit a forward voltage of approximately 2V with a typical forward current of 20mA. Controlled by the Arduino Uno, the LEDs' role extends beyond mere visualization to convey critical information about environmental parameters, necessitating a comprehensive examination of their luminosity and power consumption characteristics.

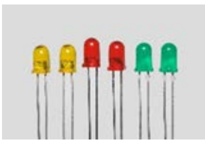

Figure 9

4. Power & Connection Components:

- Breadboard: Functioning as the hardware assembly platform, the breadboard doesn't have specific power requirements but plays a pivotal role in facilitating organized and efficient power distribution across connected components. Its impact on signal integrity and power dissipation is pertinent to the system's overall reliability.

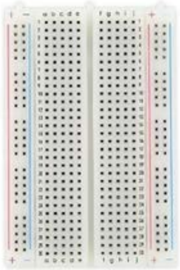

Figure 10

- Pins: Serving as electrical connectors, the pins enable seamless integration of various components. The choice of pin types and their compatibility with the Arduino Uno and other elements is crucial for maintaining signal integrity and efficient power distribution within the system.

Figure 11

IV. ADVANTAGES

- Readily available sensors are essential for efficient monitoring systems.
- The capability to interface numerous sensors allows for a detailed analysis of all gases present in the air, enhancing accuracy.
- The system enables the detection of a broad range of gases, including CO, MH4, alcohol, smoke, etc., ensuring comprehensive monitoring.
- Its simplistic, compact, and easy-to-handle design makes it user-friendly and adaptable to various environments.
- The sensors exhibit a long lifespan and are cost-effective, providing reliability and affordability for prolonged use.
- The system incorporates a simple drive circuit, facilitating straightforward operation and maintenance.
- Real-time system operation ensures timely monitoring and response to changes in air quality conditions.
- With an operating voltage of 5 volts and an operating temperature range of -20°C to +50°C, the system is versatile and suitable for diverse settings.
- The system allows for the assessment of both indoor and outdoor air quality, providing comprehensive insights for various applications.
- Visual output enhances user interface and accessibility, allowing for easy interpretation of data.
- Continuous updates reflecting changes in the percentage of air quality enable proactive measures to be taken for maintaining optimal air conditions.

V. APPLICATIONS

- Monitoring pollution levels along roadways is crucial for understanding and mitigating the environmental impact of vehicular emissions.
- Surveillance of industrial perimeters for environmental impact allows for proactive measures to be taken to minimize pollution and protect surrounding ecosystems.
- Identifying optimal sites for reference monitoring stations is essential for obtaining accurate and representative data on air quality across different regions.
- Indoor air quality monitoring is important for ensuring the health and well-being of occupants in residential, commercial, and industrial spaces.

- Creating a server using IoT to upload data with timestamp information enables real-time tracking and analysis of pollution levels, facilitating informed decision-making.
- Ensuring public accessibility to the collected data promotes transparency and community engagement in environmental conservation efforts.
- Establishing a danger threshold on the server and alerting authorities for proactive measures to safeguard public health enhances response capabilities and reduces the risk of adverse health effects due to pollution exposure.

VI. RESULTS AND DISCUSSIONS

Real-time monitoring of household parameters, including gases, dust is achieved using specialized sensors. MQ-135 identifies various harmful gases with an operating voltage range of 2.5V to 5.0V. M-35 identifies rise in sound levels and sends back data to the microcontroller. The ESP8266 module serves as the Wi-Fi backbone, establishing a private channel for parameter visualization. It connects to a Wi-Fi access point, and user ID and a write API key facilitate data transmission to the channel. Arduino UNO microcontroller processes sensor inputs, connects to Wi-Fi through the ESP8266 module, and transmits data to the private channel. The project workflow involves configuring the Wi-Fi module, connecting to an access point, converting logic levels, and transmitting sensor data to the channel, with block diagrams visually representing the data collection, processing, and uploading steps. The project shows the air quality index and sound values on the serial monitor and the serial monitor. The values rise and dip as the sound decibels increase. The air quality index changes if we light a fire near it or spray some disinfectant which changes the composition of the air.

VII. FUTURE SCOPE

The future scope of our IoT based Air and Sound Pollution Monitoring System includes expanding its capabilities with advanced sensors, data analytics and AI predictive analysis integrating with smart city infrastructure and developing user friendly interfaces for public awareness and real time alerts. Additionally, it can contribute to long term data collection for studying environmental trends and implementing targeted pollution control measures. We can scale it up gradually.

VIII. CONCLUSION

In the process of implementing this system, sensor devices are strategically deployed in the environment to gather and analyze data. This deployment brings the environment into practical scenarios, facilitating interaction with other objects through the network. Subsequently, end-users can access the collected data and analysis results via Wi-Fi.

This paper introduces an intelligent and cost-efficient embedded system designed for effective environmental monitoring, showcasing diverse models. The proposed architecture delves into the functionalities of distinct modules. The noise and air pollution monitoring system, integrating the Internet of Things (IoT) concept, underwent experimental testing to monitor two parameters, with sensor data transmitted to the cloud (Google Spreadsheets).

The collected data serves as a valuable resource for future analyses and can be easily shared with other end-users. This model holds potential for expansion, particularly in monitoring pollution in developing cities and industrial zones. Prioritizing public health protection from pollution, this model presents an efficient and budget-friendly solution for continuous environmental monitoring.

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