IOT Based Air and Noise Pollution Monitoring System

Dr. Durgaprasad Kamat [1], Jagruti Patil [2], Puja Kamble [3], Priyanka Gawali [4]

[1]*Asst Prof, Electronics and Telecommunication Engineering, Sinhgad Academy of Engineering, Pune*
[2]*Electronics and Telecommunication Engineering, Sinhgad Academy of Engineering, Pune*
[3]*Electronics and Telecommunication Engineering, Sinhgad Academy of Engineering, Pune*
[4]*Electronics and Telecommunication Engineering, Sinhgad Academy of Engineering, Pune*

---***---

Abstract - In infrastructure and industrial settings, rapid growth leads to environmental concerns such as air, water, and noise pollution, climate change, and system malfunctions. This necessitates adaptable, efficient, and cost-effective monitoring solutions. Smart sensor networks, combining computer science, wireless communication, and electronics, emerge to address these challenges. This paper proposes a solution for monitoring air and noise pollution in industrial environments using wireless embedded computing systems. The integration of Internet of Things (IoT) technology, a convergence of computer science and electronics, forms the basis of this solution. Sensing devices are connected to embedded computing systems to monitor fluctuations in noise and air pollution, as well as humidity and temperature levels, from their baseline levels. Keywords include sensor, IoT, network, MQTT, ESP32, online platform, and smart city.

Key Words: Air pollution, noise pollution, environment

1. INTRODUCTION

The central objective of employing an IoT-based system to monitor air and noise pollution is to tackle the growing concern surrounding air quality, given its critical role in sustaining human life. Pollution, claiming more than seven million lives globally each year, poses a substantial risk, particularly to individuals with pre-existing health conditions, as it can exacerbate their ailments rapidly. This IoT-driven solution is crafted to continuously gauge and evaluate air quality and noise levels in real-time, empowering individuals, communities, and authorities to effectively oversee environmental conditions. Through this system, stakeholders can enact proactive measures and data-informed strategies to alleviate air and noise pollution, thereby safeguarding public health. The proliferation of urban areas is accompanied by an increasing population density, necessitating the provision of fundamental infrastructure and services. Consequently, there is a heightened demand for devices such as sensors and handsets, offering significant opportunities for the integration of IoT technology. IoT facilitates the interconnectivity and communication of electronic devices via the internet, serving as the cornerstone of smart city initiatives. Leveraging advanced communication networks, sensors, and software, IoT enables seamless communication among devices, fostering the evolution of smart cities. These urban centers leverage IoT frameworks to streamline operations, boost efficiency, and optimize resource allocation, representing notable advancements in urban development endeavors.

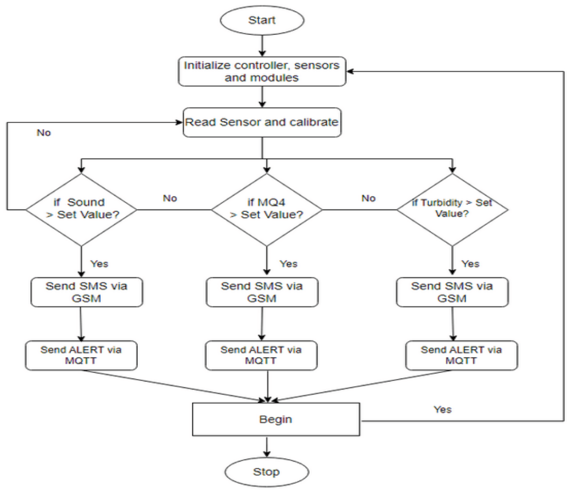
2. Motivation

The primary goal of this endeavor revolves around identifying and averting the detrimental impacts of airborne pollutants, thereby fostering a healthful environment through the analysis of accumulated data stored in the IoT cloud. In contemporary society, numerous pollution surveillance frameworks emerge, each tailored to address distinct environmental variables. The underlying motivations behind this project encapsulate several pivotal aspects: Enhancement of Public Health Preservation of Environmental Integrity Facilitation of Urban Planning and Traffic Control Detection and Tracing of Pollution Origins Establishment of Early Warning Mechanisms Mitigation of Climate Change Effects Augmentation of Quality of Life.

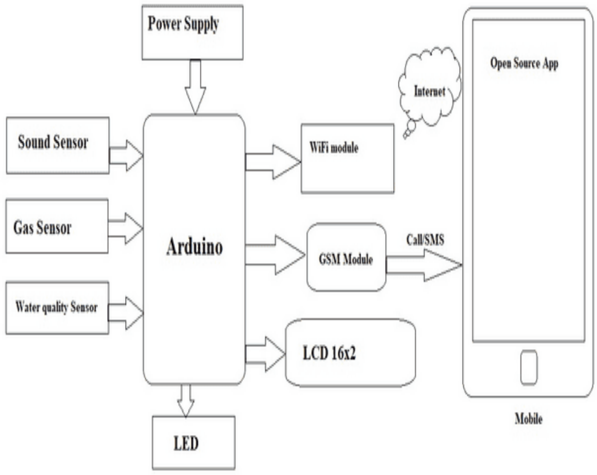
3. Problem statement

The issue of air and noise pollution is currently on the rise in modern times. Ensuring the monitoring of air quality is crucial for a healthier future and improved well-being for everyone. The proposed framework introduces a system for monitoring air quality and solid pollution, allowing for the real-time tracking and assessment of air quality and noise pollution in specific areas. Urban areas face significant environmental challenges from air and noise pollution, negatively impacting the health and welfare of inhabitants. The absence of effective real-time monitoring systems presents various hurdles, including insufficient data for decision-making, challenges in pinpointing pollution origins, and a lack of community involvement in pollution management efforts. To overcome these obstacles, there is a necessity to develop and deploy an IoT-driven Air and Noise Pollution Monitoring System.

4. Flow Chart



5. Architecture



IoT Platform for Monitoring Pollution of Smart City

Components:

1. Sound Sensors: Sound sensors are used to detect noise pollution. These sensors capture sound waves and convert them into electrical signals, which are then processed to determine noise levels in decibels (dB). These sensors can be strategically placed in the monitoring area. The sound sensor is a small board that incorporates a microphone (50Hz-10kHz) and some processing circuitry to convert the sound wave into an electrical signal. This electrical signal is fed to the on-board LM393 High Precision Comparator, which digitizes it and makes it available at the OUT pin. The module includes a potentiometer for adjusting the sensitivity of the OUT signal. Use it to set a threshold, so that when the amplitude of the sound exceeds the threshold, the module outputs LOW, otherwise HIGH. This setup is very useful for triggering an action when a certain threshold is reached. The module also includes two LEDs. The Power LED illuminates when the module is turned on, and the Status LED illuminates when the sound level exceeds the threshold value. Connections are simple. Start by connecting the module's VCC pin to the Arduino's 5V pin and the GND pin to ground.

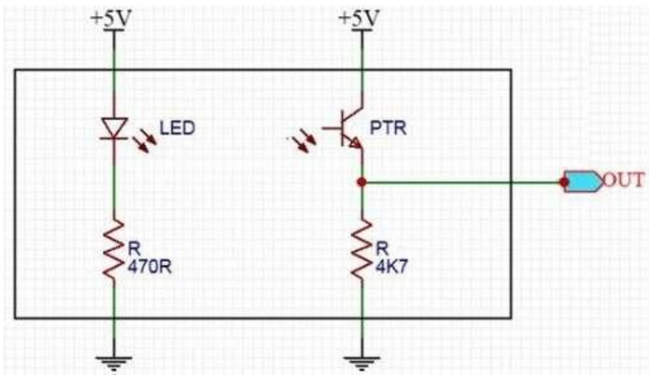
2. M4 Microcontroller: The M4 microcontroller, or similar hardware, serves as the central processing unit for the system. It collects data from the sound sensors and turbidity sensors, processes the data, and communicates with other components.

3. Turbidity Sensor: Turbidity sensors are responsible for monitoring air pollution. They measure the concentration of particles or pollutants in the air, which can be an indicator of pollution levels. These sensors can provide valuable data on air quality. Turbidity is the **cloudiness** or **haziness** of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in the air. The **measurement of turbidity** is a key test of **water quality**.

Turbidity is caused by particles **suspended** or **dissolved** in water that scatter light making the water appear **cloudy** or **murky**. Particulate matter can include sediment, especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae, and other microscopic organisms.

Measuring Turbidity

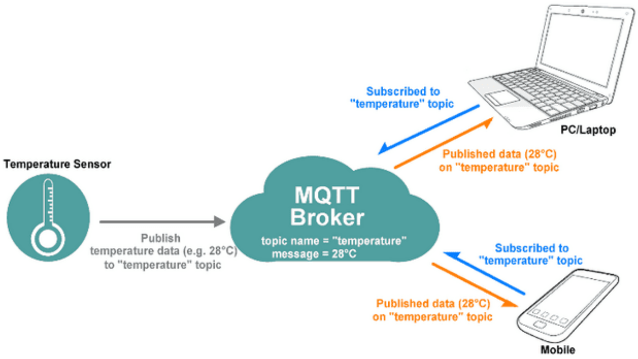
Turbidity is measured using specialized optical equipment in a laboratory or in the field. Light is directed through a water sample, and the amount of light scattered is measured. The unit of measurement is called a **Nephelometric Turbidity Unit (NTU)**, which comes in several variations. The greater the scattering of light, the higher the turbidity. Low turbidity values indicate high water clarity; high values indicate low water clarity. The gravity Arduino Turbidity sensor detects water quality by measuring the levels of turbidity. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases. The front-end sensor is an optical device comprising an LED (light sender) and a phototransistor (light receiver). The schematic of the Turbidity Sensor's inside board is given below. It has a three-wire interface: VCC (+5 V), GND (0 V) & OUT/SIGNAL.



The Turbidity sensor has a signal connector Board as well. The signal connector board is directly connected to the above circuit.

4. MQTT Protocol:

MQTT is a lightweight, efficient messaging protocol that facilitates communication between IoT devices. In this system, it is used to publish and subscribe to pollution data. The M4 microcontroller can publish data to an MQTT broker, and authorized users or central servers can subscribe to this data. MQTT is a lightweight publish-subscribe-based messaging protocol. It is quicker (faster) than other request-response based APIs like HTTP. It is developed on the base of the TCP/IP protocol. It allows remote location devices to connect, subscribe, and publish, etc. to a specific topic on the server with the help of a message broker. MQTT Broker/Message broker is a module in between the sender and the receiver. It is an element for message validation, transformation, and routing. The broker is responsible for distributing messages to the interested clients (subscribed clients) of their interested topic.



5. GSM Module: The GSM module is used for wireless communication. It enables the system to send data to a remote server or notify relevant authorities in real-time through text messages or calls. This ensures that prompt action can be taken if pollution levels exceed safe limits.

The SIM800L GSM/GPRS module is a miniature GSM modem that can be used in a variety of IoT projects. You can use this module to do almost anything a normal cell phone can do, such as sending SMS messages, making phone calls, connecting to the Internet via GPRS, and much more.
To top it all off, the module supports quad-band GSM/GPRS networks, which means it will work almost anywhere in the world.
At the heart of the module is a SIM800L GSM cellular chip from Simcom.
The operating voltage of the chip ranges from 3.4V to 4.4V, making it an ideal candidate for direct LiPo battery supply. This makes it an excellent choice for embedding in projects with limited space. All the necessary data pins of the SIM800L GSM chip are broken out to 0.1″ pitch headers, including the pins required for communication with the microcontroller over the UART. The module supports baud rates ranging from 1200 bps to 115200 bps and features automatic baud rate detection.

Process:

1. The sound sensors and turbidity sensors continuously collect data and send it to the M4 microcontroller.

2. The M4 microcontroller processes the data, making it suitable for transmission.

3. Processed data is published via MQTT to a central server or cloud platform, which can be accessed by relevant stakeholders.

4. In the event of pollution exceeding predefined thresholds, the GSM module sends alerts or notifications to authorize users, such as environmental agencies or local authorities.

5. Data analytics and visualization tools can be employed to analyze pollution trends over time, aiding in making informed decisions.

6. Applications

Monitoring air quality and noise pollution in urban areas to assess the impact on public health and quality of life.

- Urban Environmental Management
- Industrial Facilities
- Traffic Management
- Smart Buildings and Smart Cities
- Public Health monitoring
- Noise Pollution Control projects
- Environmental Research and Studies and analysis
- Agriculture and Farming sector

REFERENCES

1] Cynthia Jayapal & Parveen Sultana, International Journal of Grid and High-Performance Computing - Oct 2019.

[2] Anand Jayakumar Arumugham, International Research Journal of Eng. And Technology (IRJET)- April 2021.

[3] Rajat Sankhe & Pravin Shirodkar, International Journal of Engineering Research and Technology (IJERT).

[4] Lal Bihari Barik, International Journal of Advanced Computer science and Applications (IJACSA) Oct 2019.

[5] PV Hari Prasad & Kollu Yashwanth Kumar, International Journal of Innovative Research and Technology (IJIRCST) www.ijircst.org July 2021 ISSN 2347-5552.

[6] Pattar Sunil Mahesh, Patil Bhushan Rajendra, International journal of advanced research In instrumentation engineering-2018.

[7] Md. Zahidul Islam, International Journal of Scientific Research and Eng. Development www.ijsred.com Jan - Feb 2021. [

8] Palaghat Yashwanth Sai, International journal of advanced research in computer and communication engineering.

[9] Devika Sonawane, International Journal for Modern Trends in Science and Technology 2021. [10] Prof. Kaushik Vipul, Dr. Tanaji Dabade, journal of emerging technologies and innovative research.

BIOGRAPHIES

Dr. Durgaprasad K. Kamat received his BE degree in the field of Electronics Engineering in 1994 from Shivaji University, Kolhapur. He has completed ME in Electronics Engineering at SCOE, affiliated to SPPU, Pune in 2008. He has completed PhD in Electronics and Telecommunication Engineering at SCOE, affiliated to SPPU, Pune in 2019. He is working as Assistant Professor in the Department of Electronics and Telecommunication Engineering of Sinhgad Academy of Engineering, Pune, since 2005. His research interests are Signal Processing, Embedded Systems and Biomedical Applications. He has over 18 years of teaching experience and 7 years of industry experience. Dr. Kamat is a life member of IETE. He has published 21 papers in International Journal and seven papers in International and National Conferences.

Jagruti Patil has successfully finished her diploma in Electrical Engineering at MSBTE Mumbai. Currently, she is in the final year of her Bachelor of Engineering (BE) program, specializing in Electronics and Telecommunication Engineering at Savitribai Phule Pune University.

Puja Kamble has successfully finished her diploma in computer engineering at MSBTE Mumbai. Currently, she is in the final year of her Bachelor of Engineering (BE) program, specializing in electronics and telecommunication engineering at Savitribai Phule Pune University.

Priyanka Gawali has successfully finished her diploma in computer engineering at MSBTE Mumbai. Currently, she is in the final year of her Bachelor of Engineering (BE) program, specializing in electronics and telecommunication engineering at Savitribai Phule Pune University