IOT based Sound Pollution Monitoring System

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ABSTRACT

The pollution of sound is overhasty. To bring it in check its monitoring is extremely counsel to win this issue, we are launching a system through which the extent of sound pollution within the gird are frequently detected. The fatten pollution at such an alarming rate has started creating trouble for the living ones. The noise pollution poses a high environmental risk to human health, both direct and indirect, and it can be defined as unwanted or harmful outdoor sound. The purpose of this paper is hardware and software implementation of a noise measurement and monitoring system.

Keyword: - *air pollution, sound pollution, sensors, IOT sensors , monitoring system, raspberry Pi, AVR UNO board, MATLAB, AVR hardware.*

1. INTRODUCTION

In this context where combination of many challenges of computer science, wireless communication and electronics; the Smart Sensor Networks are an emerging field of research. In this paper a solution to monitor the noise pollution levels in industrial environment or by using wireless embedded computing system a particular area of interest is proposed. The technology like Internet of Things (IoT) is included in the form of solution which is outcome of merged field of computer science and electronics. For monitoring the fluctuation of parameters like noise pollution levels from their normal levels in this case the sensing devices are connected to the embedded computing system. For the requirement of continuous monitoring, controlling and behavior analysis this model is adaptable and distributive for any infrastructural environment. The working appearance of the proposed model is evaluated using prototype implementation, consisting of AVR UNO board, sensor devices and MATLAB with AVR hardware support package. For parameter like noise levels the implementation is tested with respect to the normal behavior levels or given specifications which provide a monitoring over the pollution control to make the environment smart and ecofriendly.

2.PROBLEM DEFINITION:

Sound Monitoring system Develop a system capable of monitoring and analyzing sound levels in various environments. Define the range of sound frequencies and amplitudes the system will monitor.

Determine the environments where the system will be deployed (e.g., offices, industrial settings, outdoor areas). Specify the level of precision required for sound measurement and analysis.Real-time monitoring: The system should continuously measure sound levels and provide immediate feedback.

Data logging: Ability to record sound level data over time for analysis and compliance purposes.

Threshold alerts: Set thresholds for acceptable sound levels and trigger alerts when exceeded.

Frequency analysis: Analyze sound frequencies to identify specific sources or patterns.

Localization: Determine the direction or origin of sound sources within the monitored area.

Technical Requirements Hardware: Specify the required sensors, microphones, processors, and connectivity options.

Software: Define the algorithms for sound analysis, data storage, and user interface.

Power considerations: Determine power requirements and options for both stationary and portable deployment ,Ensure the system complies with relevant sound level regulations and standards in the target deployment areas. Include features for generating compliance reports and exporting data for regulatory purposes.Identify potential risks such as sensor malfunction, data accuracy issues, or regulatory non-compliance, and develop mitigation strategies.

By addressing these aspects in the problem definition, the development team can ensure clarity of objectives, alignment with user needs, and a structured approach to building an effective Sound Monitoring System.

2. LITERATURE REVIEW

The air and sound pollution monitoring system is critical for detecting a wide range of gases; also, sensors have a long-life span, are readily available, are inexpensive, easy to use, and are compact. Air quality can be measured both indoors and outdoors. This system features a basic drive circuit, real-time operation, and visual output. The main goal of this document is to ensure that air and sound pollution are monitored and controlled by taking appropriate measures. The proposed paper has several limitations. 22 Humidity should be less than 95%, and precise measurements of harmful gases in ppm are impossible to detect. This paper can be used to monitor pollution levels as well as to prevent excessive pollution, which could lead to major difficulties in the future. This paper outlines how we can provide authorities with immediate alerts. The IoT technology is adopted because it is cost-effective. As a result, this technology is used to monitor air and sound pollution. [2]. The Automatic Air & Sound Management System is a step forward in providing a solution to the most pressing problem. The air and sound monitoring system solve the problem of heavily polluted places, which is a significant problem. It encourages the use of new technology while also emphasizing the need of living a healthy lifestyle. This system includes elements that allow consumers to monitor pollution levels on their mobile phones via an application.

As a result, monitoring the environment by municipal officials and civilians becomes very dependable and efficient. Allowing civilians to participate in this process adds to its worth. This concept of IoT is important for the well-being of society because citizens are now equally informed and curious about their environment. It is also implemented using cutting-edge technologies. [5]

The author[6] demonstrates that both the local residents and the government have access to the Air and Sound Pollution Monitoring equipment. The device will be installed via a mobile application that will display real-time updates on the degree of pollution in the vicinity. The mobile applications will also be installed in the fire brigades themselves so that if a fire is taking place nearby, it can be controlled in time to minimise loss of life and property.

This device is also capable of detecting the fire in its area and notifying the fire brigade authorities so that they can take the necessary actions accordingly. The IOT, a growing field of technology based on the combination of electronics and computer science, is how this system operates The authors of [7] illustrate a flexible and distributing approach for controlling the framework associated to the environment. The system is built with a four-layer architecture and a separate module for monitoring sound and air pollution, among other functions. Information is provided on the parameter for monitoring and controlling noise and air pollution in layer 1. An actuator in Layer 2 is made up of its functional properties and traits. Actuators' data ownership and decision-making will take place in layer 3, and rational surroundings will occur in layer 4. The author [9] presents measurement results obtained by an MCS solution for air and noise pollution monitoring by means of wearable sensors and mobile application Mobile community sensors enable citizens to collect and share sensor data on the move in urban environments. MCS services can produce dense sensor readings and provide means to discover new phenomena in urban environments. Noise and air pollution can be related and are strongly dependent on the traffic exposure, according to researchers at the University of Zagreb in Croatia. The average noise level is almost 3 decibels higher during peak hour and NO_2 concentrations are significantly lower during off-peak hour.

The author [10] presents a mobile crowdsensing (system for monitoring noise pollution and air quality. More specifically, from sensor calibration through data collecting and processing, they have demonstrated real-world deployment experience. Initial findings indicate a strong correlation between air and noise pollution, which is worse during rush hours because there are more vehicles on the roads.

3. PROPOSED WORK

Define the purpose of the sound monitoring system. Is it for environmental monitoring, security purposes, or something else?

Requirements Gathering: Identify the specific requirements of the system. This could include the range of frequencies to be monitored, the sensitivity of the microphone, environmental conditions it will operate in, and any legal or regulatory requirements.

System Design:

Hardware Selection: Choose appropriate hardware components such as microphones, amplifiers, analog-to-digital converters, and processing units.

Software Design: Develop the software architecture for processing and analyzing the captured sound data. This might include algorithms for noise filtering, pattern recognition, and anomaly detection.

Data Storage and Management**:** Determine how sound data will be stored, managed, and accessed. This could involve databases, cloud storage, or local storage solutions.

User Interface: Design a user-friendly interface for configuring the system, viewing real-time data, and accessing historical recordings.

Implementation:

Hardware Assembly: Build or procure the necessary hardware components and assemble them into a functioning system.

Software Development: Write the software code for capturing, processing, and analyzing sound data. This may involve programming languages such as Python, C/C++, or MATLAB.

Integration: Integrate the hardware and software components to create a complete sound monitoring system.

Testing and Validation:

Functional Testing: Verify that the system meets the specified requirements and functions correctly under various conditions.

Performance Testing: Evaluate the performance of the system in terms of accuracy, sensitivity, response time, and reliability.

Validation: Validate the system against real-world scenarios and compare its performance with existing solutions or standards.

Deployment:

Installation: Deploy the sound monitoring system in the target environment, ensuring proper placement of microphones and connectivity to power and data networks.

Configuration: Configure the system settings according to the specific requirements of the deployment site.

Training: Provide training to users on how to operate the system, interpret the data, and respond to alerts or anomalies.

Maintenance and Support:

Monitoring: Regularly monitor the system to ensure it is functioning correctly and troubleshoot any issues that arise.

Updates and Upgrades: Apply software updates and hardware upgrades as needed to improve performance or address security vulnerabilities.

Technical Support: Provide ongoing technical support to users, including troubleshooting assistance and guidance on system optimization.

Documentation:

User Manual: Create a comprehensive user manual that provides instructions for operating the system and troubleshooting common issues.

Technical Documentation: Document the system architecture, hardware specifications, software algorithms, and data formats for future reference and maintenance.

Evaluation:

Feedback Collection: Gather feedback from users to identify areas for improvement and gather suggestions for future enhancements.

Performance Evaluation: Continuously evaluate the performance of the system against key metrics and make adjustments as needed.

Future Enhancements:

Based on user feedback and advancements in technology, plan for future enhancements or expansions of the sound monitoring system to further improve its functionality and effectiveness.

By following these steps, you can create a robust and effective sound monitoring system tailored to your specific requirement

4. OBJECTIVES

Noise Level Measurement: Accurately measure and quantify noise levels in different environments.

Data Collection: Gather data on noise pollution trends over time and across locations.

Identify Hotspots: Pinpoint areas with high levels of noise pollution for targeted interventions.

Compliance Monitoring: Ensure compliance with noise regulations and standards.

Alerting: Provide real-time alerts when noise levels exceed acceptable limits.

Public Awareness: Raise awareness about the impacts of noise pollution on health and well-being.

Policy Development: Support the development of effective noise abatement policies based on data-driven insights.

Research: Facilitate research into the causes and effects of noise pollution for better mitigation strategies.

Community Engagement: Engage communities in monitoring and addressing noise pollution issues.

Long-term Planning: Inform urban planning and infrastructure development to mitigate future noise pollution.

6. METHODOLOGY

The proposed system uses Sound Sensor, Microcontroller unit i.e., Node MCU which is also a data transmission module ESP8266 Wi-Fi module. The components used in this proposed system are shown in Table.1. along with their purpose in this proposed system The Microcontroller Unit is a significant part of the system which is developed for Sound Monitoring, Node MCU is quite a small size, compatible with IoT projects. MCU has an on- chip ADC which converts the output analog signal of the sensors to digital signals. So, to get this analog output from the sensor, the sensor's analog output will be connected to the analog pins of MCU. All the sensor data is processed by the MCU and updated to the BLYNK server using the Wi-Fi data communication module ESP8266 (Node MCU) to the central server. Node MCU detects the value of the sound sensor in decibels and further, an average value is set above which the value of sound is said to be “HIGH” which is displayed on the LCD screen. Also, if the value of the sound sensor is more than the desired value then the LEDs bulb glows. It can be seen from the block diagram in Fig. 1, that in the proposed module sound sensor is used to measure sound level in the surrounding. The sensor input is further processed through Node MCU and then sent to BLYNK server. LEDs connected to the Node MCU operates on the value of the sound sensor. If the level of sound is below the value of 200, none of the LED’s glows. If the sound level is between 200 and 500, GREEN led glows while if the sound level is between 500 and 700, YELLOW led glows and if the level of sound is above 700, RED led glows and along with the LED, the buzzer also starts to beep indicating that the level of sound has increased to a greater extent.

7. WORKING :

Sound Monitoring System begins with the initialization process. During this first stage, each hardware component, including the Node MCU, LEDs, LM393(Sound Sensor), Breadbord ,power supply , buzzer undergoes meticulous setup to establish seamless communication channels. This ensures that all components are properly configured and ready for connecting .

STEP 1. Hardware Setup:

- Microcontroller: The core of the system, responsible for collecting sensor data, processing it, and transmitting it to the cloud. Popular options include Arduino Uno, ESP8266, or Raspberry Pi.
- Sound Sensor: Converts sound waves into electrical signals. Microphones like the electret microphone are commonly used. You might need an amplifier circuit depending on the sensor.
- Power Supply: Provides power to the system. This can be a USB connection, batteries, or a solar panel for remote deployments.

STEP 2. Sensor Data Acquisition:

- The microcontroller connects to the sound sensor.
- The sound sensor converts the varying sound pressure levels (waves) into electrical signals (voltage).
- The microcontroller's Analog-to-Digital Converter (ADC) reads the voltage from the sensor and converts it into digital data (numerical values).

STEP 3. Data Processing and Calibration:

- The raw digital data from the ADC might need calibration to represent actual sound pressure levels in decibels (dB). This can involve applying conversion factors based on sensor specifications.
- You can set thresholds to define noise pollution levels. For example, a value above 80 dB might be considered excessive noise.

STEP 4. Communication and Data Transmission:

- The microcontroller transmits the processed sound level data wirelessly to the cloud platform.
- Wi-Fi modules like ESP8266 can be used for local network connections.
- Cellular connectivity options like SIM cards can be used for wider range data transmission (if applicable).

STEP 5. Cloud Platform and Data Visualization:

- The transmitted data is received by a cloud platform like Firebase, AWS IoT, or ThingSpeak.
- The platform stores the data securely and allows for visualization through dashboards and charts.
- Real-time or historical sound level data can be displayed.

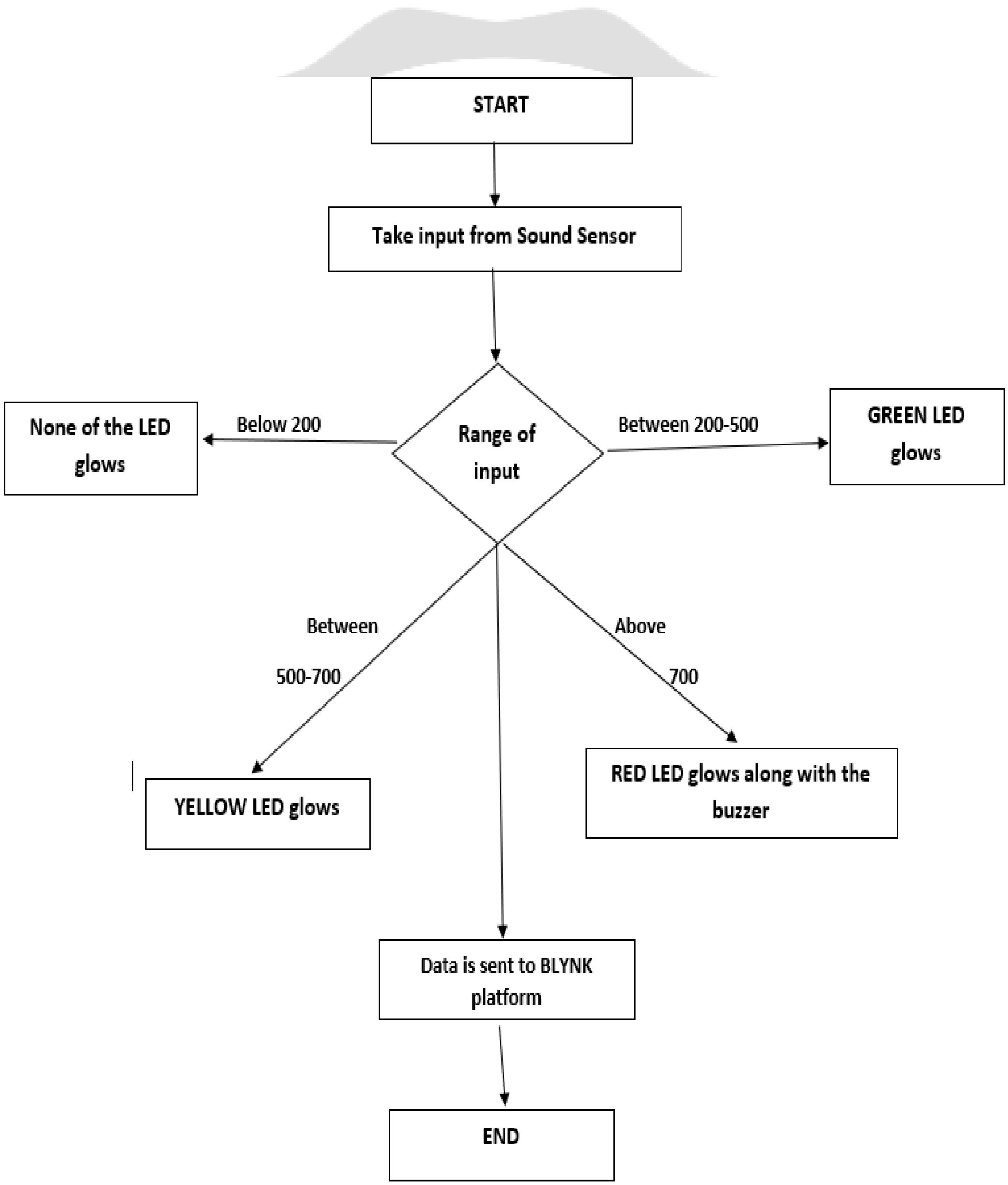
STEP 6. Alerts and Notifications (Optional):

- The system can be configured to send alerts or notifications when noise levels exceed predefined thresholds.

- Email or SMS alerts can be sent to authorities or residents in the area.
- Visual or audible alerts (LEDs, buzzers) can be integrated into the local system for immediate awareness.

STEP 7. User Interface (Optional):

- A web interface or mobile app can be developed to access the data remotely.
- Users can view real-time and historical noise levels, track trends, and potentially manage alerts.



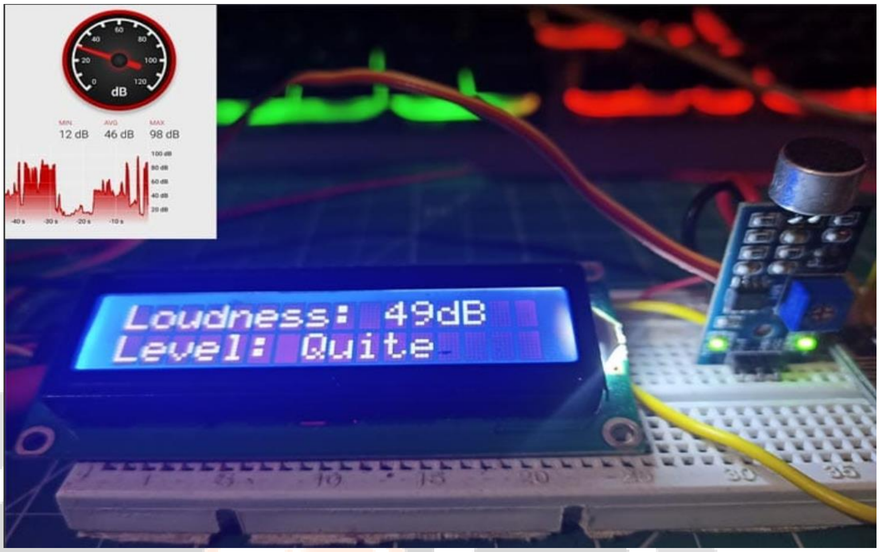


Fig -2 : Model Photo

8.3 Advantages

1. Identifying Noise Sources: A sound pollution monitoring system can help pinpoint the exact sources of noise, allowing for targeted mitigation measures.

2. Assessing Noise Levels: By continuously monitoring noise levels, these systems provide accurate data for assessing and comparing noise pollution in different areas.

3. Enforcing Noise Regulations: Sound pollution monitoring systems enable authorities to enforce noise regulations effectively, ensuring compliance and maintaining a quieter environment.

4. Public Awareness and Education: By providing real-time noise data, these systems raise public awareness about the impact of noise pollution on health and well-being.

5. Developing Noise Reduction Strategies: The data collected by sound pollution monitoring systems can be used to develop effective strategies for noise reduction .

8.4 Disadvantages

Cost: Implementing and maintaining a sound pollution monitoring system can be expensive, especially for larger areas or cities.

2. Privacy Concerns: Continuous monitoring of sound levels raises privacy concerns as it may capture conversations or other private activities.

3. Technical Challenges: These systems may face technical challenges like calibration issues, data accuracy, and maintenance requirements.

4. Limited Scope: Sound pollution monitoring systems primarily focus on noise levels and may not capture other aspects of environmental pollution.

9. APPLICATION :

1. Roadside pollution Monitoring.
2. Industrial Perimeter Monitoring.
3. Site selection for reference monitoring stations.
4. Indoor Air Quality Monitoring.
5. Design server using IoT and upload data on that server with date and time.
6. To make this data available to the common man.
7. To set a danger limit on that server and inform authorities to take future actions for wellbeing.

10. FUTURE SCOPE

1. Integration with Smart Cities

IoT and Sensor Networks: The integration of sound sensors into the Internet of Things (IoT) will enable real-time monitoring and data collection across urban environments. This can help city planners and authorities manage noise pollution more effectively.

Data Analytics and AI: Leveraging big data and artificial intelligence, these systems can predict noise pollution trends, identify sources, and suggest mitigation strategies.

2. Advanced Sensor Technology

Enhanced Accuracy and Sensitivity: Future sensors will likely be more accurate and sensitive, capable of detecting a wider range of frequencies and sound levels.

Miniaturization and Portability: Smaller, portable sensors can be deployed in more locations, providing more granular data on sound pollution.

11. CONCLUSION

This technology assists in sensing the level of noise in the environment and providing relevant warnings to people. It can also be used in combination with an air monitoring system to enhance its use. This system is fully helpful to save lives and overcome all the problems related to the environment.

The smart way to monitor environment and an efficient, low cost embedded system is presented with different models in this paper. In the proposed architecture functions of different modules were discussed. The noise and air pollution monitoring system with Internet of Things (IoT) concept experimentally tested for monitoring two parameters. It also sent the sensor parameters to the cloud (Google Spread Sheets).

12. REFERENCES

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