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# REAL-TIME NOISE MONITORING WITH IOT: ENHANCING URBAN ACOUSTIC ENVIRONMENT

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## ABSTRACT

In modern cities, as the population grows significantly, noise pollution likewise rises at a never-before-seen rate. This system offers a low-cost, adaptable, and dependable automation system with internet access, remote device control via a web application, and individualized alert messages using a Raspberry Pi. The suggested method makes use of an Internet of Things [IoT] paradigm to identify ambient noises and human speech in a closed space. The alert messages are also readable by the user. This research project uses a Raspberry Pi to automate a noise detection system.

The Internet of Things can be used to accomplish these tasks. As an illustration, it should be quite helpful in libraries to keep quiet for extended periods of time. This system's ability to lessen noise pollution is another benefit. The functions of this application have been programmed using Python libraries and the Flask programming language. A device known as a Raspberry pi can be used to implement this application. In the workplace, classroom, and library, the recommended noise detector system can be used to identify noisy individuals so that appropriate action can be taken against them.

**Keywords:** Noise Detection, Raspberry Pi, Internet Of Things, Python Libraries, Flask.

## I. INTRODUCTION

The proposed system leverages advanced Internet of Things (IoT) technology to implement a real-time noise monitoring solution tailored for environments where acoustic comfort is essential, such as libraries, offices, and hospitals. By continuously analyzing ambient sound levels , the system provides a proactive approach to managing environmental noise pollution. When sound levels exceed predefined thresholds, it delivers instant alerts. This solution is particularly valuable in noise-sensitive settings, ensuring minimal disruption to well-being and productivity. The system's capability to operate efficiently in confined spaces highlights its practicality for localized noise control. However, it relies on a stable internet connection for real-time data transmission and alerting, making it ideal for smart building ecosystems where connectivity and automation are integral.

## II. LITERATURE SURVEY

IoT-Based Air and Sound Pollution Monitoring System for Smart Environment (2022)-

This system uses MQ135 sensors for air quality monitoring (NH3, CO2) and a noise sensor for decibel tracking. When pollution surpasses thresholds, a buzzer alerts authorities. It provides a scalable, low-cost solution for urban pollution monitoring.

A Real-Time Noise Detector for Patient Monitoring at Hospital Wards (2024)-

The system utilizes KY-038 sound sensors and ESP8266 Node MCU for continuous noise monitoring in hospitals. Noise data is collected using Decibel X, stored in Firebase, and analysed to trigger alerts when exceeding WHO noise thresholds, improving patient recovery.

Librosa: Audio and Music Signal Analysis in Python (2015)-

Librosa is a Python library offering tools for audio signal processing, including spectral analysis and pitch detection. It supports modular functions like STFT and MFCCs, aiding music information retrieval and research in audio processing.

Automation of Noise Detection Using Internet of Things (2021)-

An Arduino Nano-based system monitors noise in libraries, alerting users via smartphones when noise exceeds set thresholds. The system is implemented with C programming and Pick2kit, offering a cost-effective noise management solution for enclosed areas.

Designing an IoT-Based System for Monitoring Noise Levels (2023)-

This low-cost IoT system monitors noise in universities using Autodesk Fusion 360 for design and MySQL for storage. It visualizes noise data with ArcGIS Pro, identifying noise pollution hotspots and helping improve urban living conditions in educational settings.

Development of Real-time IoT-Based Air and Noise Monitoring System (2021)-

Using ESP8266 Node MCU, the system monitors air (MQ9 sensor for CO2) and noise (LM393 sensor). Data is transmitted to Thing-Speak for real-time visualization, with high accuracy (97.86% for noise), making it suitable for industrial pollution monitoring.

A Real-Time Noise Monitoring System Based on Internet of Things for Enhanced Acoustic Comfort and Occupational Health (2020)-

The system uses mobile computing and wireless sensors to monitor noise pollution, providing continuous data through a web interface. Tested in a laboratory, it tracked sound levels (46–53 dBA), proving its scalability for occupational health applications.

IoT Based Air and Noise Pollution Monitoring System (2021)-

This system uses MQ135 gas sensors and LM393 sound sensors to track pollution, transmitting data to Thing-Speak for real-time analysis. Its cost-efficiency and portability make it ideal for small spaces like homes and schools.

Distributed Sensor Network for Noise Monitoring in Industrial Environment with Raspberry Pi-

A distributed sensor network employing Raspberry Pi monitors noise in industrial environments. Real-time noise data is collected through multiple sensors, ensuring continuous and reliable data for effective pollution control in industrial settings.

On the Application of the Raspberry Pi as an Advanced Acoustic Sensor Network for Noise Monitoring (2016)-

The Raspberry Pi is used in this low-cost acoustic sensor network to detect noise in real time. It shares data over the Internet of Things and computes parameters like Lp, Leq, and Lden on-board. Its usefulness for long-term noise monitoring in smart cities was shown in a pilot test.

## III. METHODOLOGY

### A. Material

In order to ensure acoustic comfort for enhanced living environments and occupational health, the Raspberry Pi is suggested as a key instrument. The configuration and software-hardware integration of this system are built around the Raspberry Pi. A software web interface is developed for communication purposes, containing all the alerts' visual and stored data. Using Web Services, the gathered data is kept in a SQL Server database. The authors used Flask and Python to develop a Web portal for data access. The SMTP Services are used to facilitate user network requests and to exchange the data that the prototype has acquired. The Flask interface, which the Raspberry Pi is connected to, is then immediately connected, via SQL Server authentication, to the SQL Server database. The software link diagram and system architecture are displayed in Figure 1.

### B. Methods

The proposed noise monitoring system is designed to capture, analyse , and respond to real-time audio data. The primary hardware component is a Raspberry Pi, which is interfaced with a microphone for continuous audio capture. The audio is processed in short intervals, with feature extraction happening in near real-time. This allows the system to evaluate noise levels and determine whether they exceed a user-defined threshold.

#### (1) Audio Processing:

The system uses the Python-based Librosa library for audio signal processing. Several important audio features, such as amplitude and frequency ,are extracted from the recorded audio. One of the principal approaches applied is the Fast-Time Fourier Transform , which translates the audio signal from the time domain into the frequency domain. This is crucial to comprehending the sound's frequency components since loud or disruptive noises are frequently associated with high frequencies. Furthermore, the system computes the signal's Root Mean Square (RMS) energy, offering a dependable gauge of the audio's intensity or volume. By comparing the calculated RMS energy with a predefined noise threshold, the system can detect whether the current noise level exceeds acceptable limits.

**(2) Noise Detection Logic:**

The noise detection mechanism is based on the comparison of the real-time calculated features (like RMS energy and frequency) with predefined thresholds. Users are given the option to configure these thresholds via a user-friendly web interface, enabling customization based on specific environmental requirements, such as quiet office spaces or louder industrial settings. If the noise level surpasses the threshold, the system triggers an alarm.

**(3) User Interface:**

The Flask web application acts as the user interface, allowing users to interact with the system. This interface is built using HTML, CSS, and JavaScript for a modern and intuitive experience. Through the interface, users can:

- Monitor real-time audio data and its analysis.
- Adjust the threshold values for noise detection.
- Access visualizations of the audio signals, such as amplitude and frequency graphs, which are generated using the Matplotlib library.
- View historical noise data stored in the system's database.

**(4) Database Management:**

All detected noise events and their associated timestamps are stored in a SQLite database . This database allows the system to keep a comprehensive log of historical noise events, including the intensity of the noise and the time of occurrence. The web application provides a way for users to query and visualize this historical data, offering insights into noise patterns over time.

**(5) Notification System:**

The system includes a notification system designed to alert users when noise levels surpass the defined threshold. Simple Mail Transfer Protocol (SMTP) for sending email alerts, this implementation used to transfer files containing detailed noise alert information. This provides a more secure and controlled method for managing notifications .By employing SMTP, the system allows for flexibility in how notifications are handled, making it suitable for environments with strict security policies .

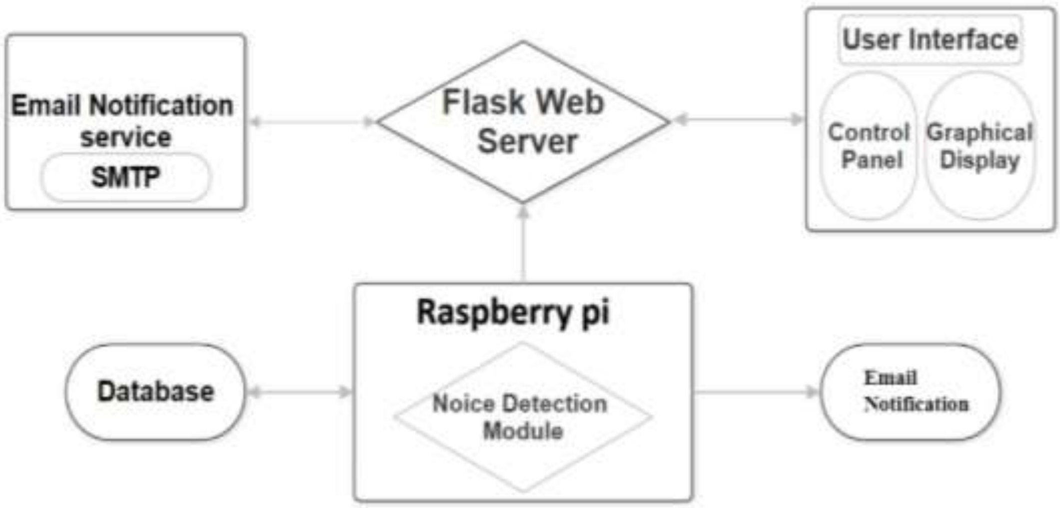


**Fig 1:** IOT-Based Noise Monitoring System Architecture

**C. Aims**

The authors' goal is to provide an accurate, affordably priced system that is simple to use and configure for the average user. Additionally, it must to be able to notify the user manager in real time when the sound levels surpass predetermined thresholds. Thus, the authors selected a reasonably cost yet remarkably dependable microphone and a CPU with integrated Wi-Fi. The two primary components of the proposed system are the Raspberry Pi microcontroller and the analog sound level meter made with a Flask-based web interface. The system contains tools for email notifications and visual alerts for residents, and it logs information on sound level alarms that have occurred.

## IV. MODELING AND ANALYSIS

| SR.NO | PAPER TITLE | METHODOLOGY | RESULT / OUTCOME |
|---|---|---|---|
| 1. | A Real-Time Noise Detector for patient Monitoring at Hospital Wards. | Utilized Jot components like ESP8266 and KY038 Sound sensor to detect noise level at a hospital ward. Data stored in firebase. | Effective detection : Successfully identified noise in hospital wards. Limitation : sensors limited Range mainly used for lower amplitude sound. |
| 2. | IOT Based Air Sound Pollution Monitoring for smart Environment | Sensor used Arduino with MQ-135 air sensor and noise sensor with Data processed and displayed. Buzzer alerts authority if level exceeds threshold. | Accurate Monitoring : Detected fluctuating pollution levels (50-65dB noise) Limitation : Basic system limited to noise level air quality detection without centralized wireless monitoring. |
| 3. | Development of Real Time IOT Based Air and Noise Monitoring System. | Node MCU ESP8266 for cloud communication with Thing-Speak MQ9 for gas detection and LM343 for noise. | High accuracy : Achieved 91.92% for gas achieved 97.86% for noise. Alert System- Email alerts sent when threshold exceeds. Limitation : Variation in reading due to sensor smaller area |
| 4. | Automation of Noise Detection using Internet of things | Developed using Arduino UNO, IOT device recognition module. C Language used for signal processing & noise Detection. Alerts via smartphone app. | Realtime Detection Successfully classified noise by decibel level. Limitation : limited to human voice. |

## V. CONCLUSION

This study suggests a low-cost Internet of Things (IoT)-based noise monitoring system that tracks noise levels in real time and has a web interface for data visualization and analysis. Because it can be customized to fit any kind of building, the device can measure noise pollution and contribute significantly to medical diagnostics and smart city projects. Its real-time tracking facilitates sound level adjustment and acoustic comfort enhancement measures. While commercial solutions are expensive, this system provides an affordable alternative. However, further validation is required, especially for outdoor environments. Future improvements aim to expand its use in schools, hospitals, and elderly care facilities.

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