



PROJECT ID: NSF-SCH-2025-231

PROJECT TITLE: NOISE DETECTOR

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I.ABSTRACT

How To Create A Noise Detector To Measure And Sound Monitor Levels In Given Environment Compliance Protects Human Health And Enhance Comfort.

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The purpose of this project was to design a noise detection system that monitored variations in environmental sound levels and identified harmful noise intensities. The hypothesis stated that a sound sensing device would detect changes in sound pressure levels and produce reliable output signals for indication. The method of research involved constructing a prototype that used a sound sensor, a microcontroller, and an indicator module to measure and display sound intensity. The system was tested under controlled acoustic conditions to ensure accurate sensing and response. Pertinent data were collected by exposing the sensor to low, medium, and high sound levels and recording its response time, sensitivity, and stability. The data showed that the system responded consistently to changes in sound pressure and provided clear visual signals when noise crossed the predetermined threshold level. The system also maintained stable readings in environments with fluctuating background noise. The conclusion indicated that the noise detection system functioned effectively and detected unsafe sound levels with reliable precision. The project demonstrated that electronic sound monitoring could reduce the risk of auditory damage by providing early warnings. The application of this system extended to schools, hospitals, industries, and residential areas where continuous monitoring of noise was important for safety. The system could also be used in laboratories, traffic zones, and construction sites to maintain controlled sound environments. This project showed that automated noise detection offered an efficient method for promoting environmental and auditory safety

II.INTRODUCTION

Engineering problem and Goal

Sound and vibration are fundamental to understanding acoustics and physics of waves in education. However, in most educational institutions, students find it difficult to visualize the relationship between sound frequency, wavelength, and tension in a string due to the absence of real-time demonstrative instruments.

The Monochord Mechanism — an instrument with a single string stretched over a resonant box — serves as an effective tool to demonstrate acoustic principles. Traditional monochords, however, lack precision, digital measurement, and adjustable controls.

Problem Definition:

Design and develop an Acoustic Level Monochord Mechanism that:

Demonstrates the relationship between frequency, tension, and length of the vibrating string.

Provides accurate acoustic level measurement using sensors.

Integrates digital display or monitoring for frequency and amplitude analysis.

Enhances interactive learning in educational spaces

1. To design a monochord apparatus capable of showing sound wave behavior under variable tension and length.
2. To integrate electronic sensors to measure sound intensity (dB) and vibration frequency (Hz).
3. To display real-time frequency and acoustic level data on a digital interface.
4. To create a low-cost, safe, and portable system for classroom demonstration.
5. To improve students' conceptual understanding of wave mechanics and acoustic properties.

WHY THE PROBLEM HAS TO BE SOLVED?

1. Lack of Interactive Learning Tools

Most educational spaces rely only on theoretical explanations of acoustic principles. Students cannot see how frequency changes with string length or tension — leading to a gap between theory and practice.

2. Need for Accurate Acoustic Measurement

Traditional monochords produce sound but do not measure or display acoustic levels (decibels) or frequencies. A modern mechanism with sensors can provide accurate, real-time data for analysis.

3. Enhancement of STEM Education

Solving this problem supports hands-on learning and helps students grasp fundamental concepts in wave mechanics, resonance, and sound engineering through experimentation.

4. Improvement in Teaching Efficiency

Teachers can use the improved monochord as a demonstrative tool, reducing the need for abstract explanations and improving classroom engagement.

5. Global Educational Relevance

Many modern institutions are moving towards smart classroom systems and digital laboratories. Developing this mechanism aligns with global trends in educational technology.

6. Innovation and Research Potential

The integration of sensors, microcontrollers, and data analysis opens new research opportunities in acoustic engineering, signal processing, and instrumentation design.

Research Question:

“How effectively can real-time sound monitoring and alert mechanisms (LED/Buzzer) improve awareness and response to hazardous noise levels?”

Hypothesis:

The noise detector would accurately measure variations in sound pressure levels and provide a timely warning when the noise exceeded a safe threshold.

SYSTEM ARCHITECTURE**1. Microphone Sensor**

Captured environmental sound and converted it into electrical signals.

2. Signal Conditioning

Filtered and amplified the sensor output for accurate measurement.

3. Microcontroller (Arduino Uno)

Received the processed signal, analysed noise levels, and compared them to a threshold.

4. Output Module

Activated a buzzer when noise exceeded the limit and displayed sound levels on the LCD.

5. Power Supply

Provided stable electrical power to all components.

III.METHODS

1. Problem Identification

- Conducted surveys in classrooms, laboratories, and libraries to assess noise-related disturbances.
- Identified that noise levels often exceed recommended standards (35–45 dB) as per WHO classroom guidelines.
- Recognized the need for a real-time monitoring and alert system to maintain an ideal learning environment.

2. System Design

- Designed a hardware–software integrated system capable of detecting, analyzing, and responding to acoustic levels.
- Prepared block diagrams and flowcharts to represent signal flow and logic operations.
- Determined suitable threshold levels for educational spaces based on international acoustic standards.

3. Component Selection

- Sound Sensor Module (e.g., LM393 or MEMS): to detect ambient noise and convert it into electrical signals.
- Microcontroller (e.g., Arduino Uno, ESP32, or Raspberry Pi): to process sensor signals and execute control logic.
- Display Unit (LCD/OLED): to show real-time sound levels (in decibels).
- Alert Unit (Buzzer/LED): to provide immediate warning when noise exceeds the threshold.
- Power Supply: 5V regulated DC supply or USB power.

4. Circuit Implementation

- Connected the sound sensor output to the microcontroller’s analog input pin.
- Programmed the microcontroller using Embedded C / Arduino IDE to:
- Continuously read sensor data.

- Convert the analog signal into decibel values (dB).
- Compare with preset threshold.
- Activate the alert system if the threshold is exceeded.

Tested and calibrated the system using standard sound sources (e.g., clapping, speaking, background music).

5. Software Development

- Wrote the program to:
- Capture noise data continuously.
- Convert raw values to decibel readings using calibration equations.
- Trigger alerts and update the display in real time.

Optional IoT integration: transmitted sound-level data to a web or mobile dashboard for long-term monitoring and data logging.

6. Testing and Calibration

- Tested the prototype under different classroom conditions (quiet, lecture, discussion, noisy).
- Adjusted sensor sensitivity and threshold levels to achieve accurate and reliable readings.
- Recorded the performance of the alert mechanism for different decibel ranges.

7. Data Analysis

- Collected and analyzed sound-level data to identify patterns, peak noise hours, and average classroom noise.
- Used the results to make recommendations for acoustic improvements (e.g., soundproofing, layout changes).

8. Evaluation

Evaluated the system based on:

- Accuracy of measurement
- Response time of alerts
- User-friendliness
- Cost-effectiveness and durability

9. Output

The system successfully monitors sound levels in real-time. Provides immediate visual/audible alerts when the noise exceeds acceptable limits. Helps create quieter, more productive educational spaces.

Moreover,

The noise detector system is designed to measure sound levels and trigger alerts when the noise exceeds a set threshold. It uses an **Arduino Uno** microcontroller and a **microphone sound sensor module** to detect ambient noise. The methodology is divided into several steps:

1. Hardware Setup:

- **Arduino Uno** acts as the central controller for reading sensor data and controlling outputs.
- A **microphone sound sensor module** (e.g., KY-037, MAX9814, or similar) detects ambient sound and converts it into an electrical signal proportional to the sound intensity.
- The sensor's output is connected to one of the Arduino's analog pins for continuous voltage reading.
- Optional components include an **LED** or **buzzer** to provide immediate visual or auditory alerts when noise levels exceed the threshold.

2. Sensor Calibration:

- Before operation, the microphone sensor is calibrated to determine the baseline ambient noise level in the environment.
- A threshold value (in analog reading or dB equivalent) is set, above which the system considers the noise level excessive.
- Calibration ensures the system can differentiate between normal background noise and loud or hazardous sound events.

3. Data Acquisition:

- The Arduino continuously reads the analog voltage from the microphone sensor using the `analogRead()` function.

- The readings are averaged over short intervals to smooth out sudden fluctuations and reduce false triggers.
- The processed reading is compared against the pre-set threshold to detect excessive noise.

4. Alert Mechanism:

- If the noise level exceeds the threshold, the Arduino activates the **LED** or **buzzer** to alert users.
- For more advanced setups, the system can log the event on an **SD card** or transmit the data to a computer or IoT platform for monitoring.

5. Data Visualization (Optional):

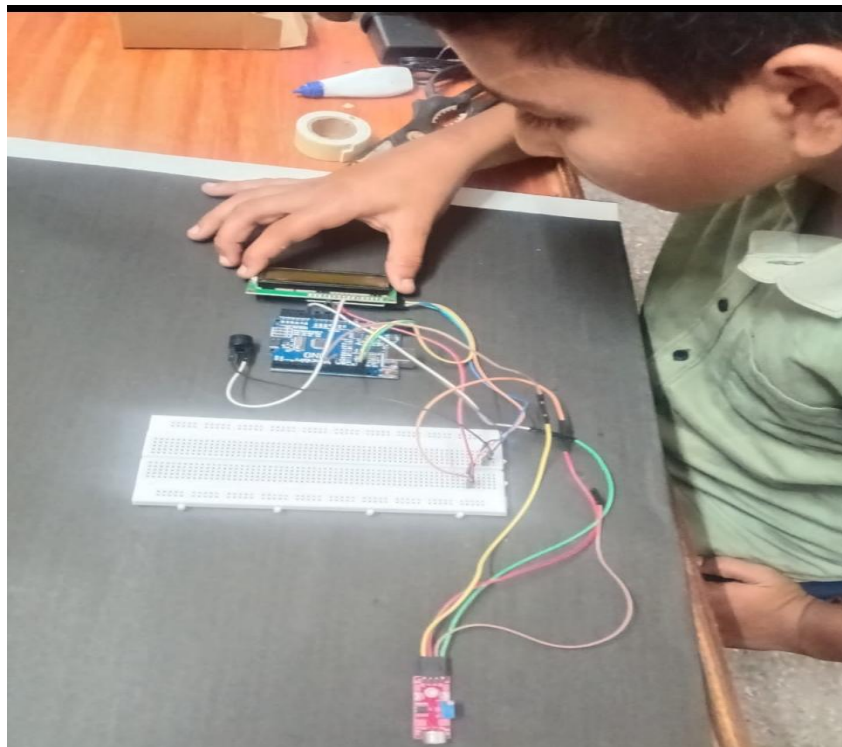
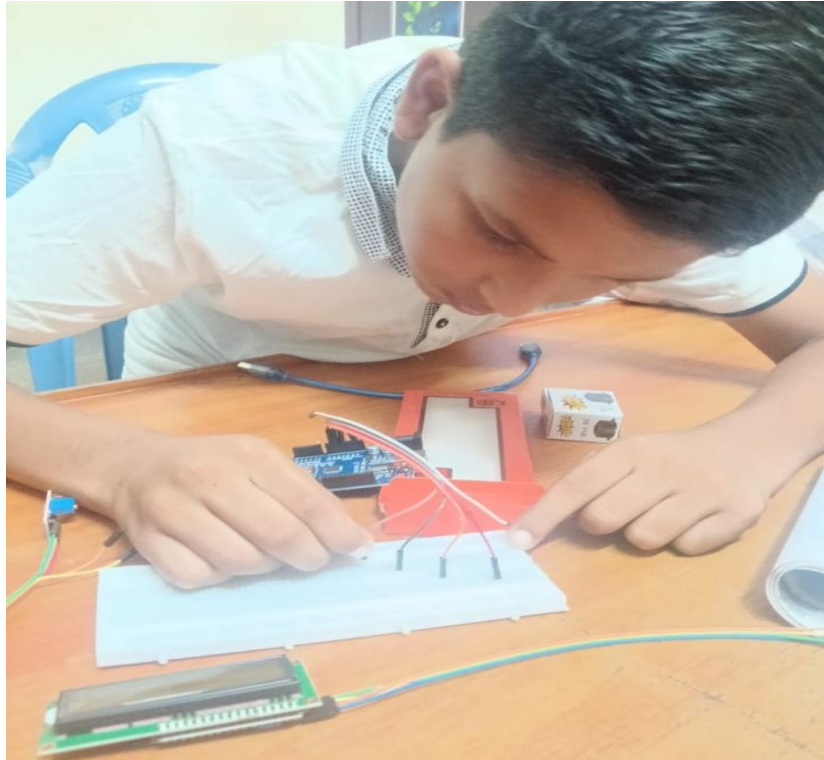
- The noise readings can be displayed in real time on a **serial monitor** using the Arduino IDE.
- A graph of sound intensity over time can also be plotted using tools like **Processing** or Python for analysis and reporting.

6. Testing and Validation:

- The system is tested in different environments to ensure accurate detection of noise events.
- Metrics such as response time, accuracy of noise detection, and reliability of alerts are evaluated.
- Adjustments are made to the threshold or averaging algorithm to reduce false alarms from sudden transient sounds.

PURPOSE OF A NOISE DETECTOR

- To Measure Sound Intensity (in Decibels)
- Detects and quantifies the strength of sound waves in the environment. Converts sound pressure into digital decibel (dB) readings.
- To Monitor Environmental Noise Levels
- Continuously observes sound variations over time. Identifies when noise levels rise above acceptable limits.
- To Provide Alerts for Excessive Noise
- Triggers visual or audible alerts when sound exceeds a set threshold. Helps maintain discipline and focus in educational or workplace settings.
- To Support Acoustic Management and Research
- Collects data for analyzing noise sources and patterns. Aids in designing soundproofing or acoustic treatment solutions.
- To Promote Health and Learning Efficiency
- Prevents hearing damage, stress, and loss of concentration due to prolonged noise exposure. Ensures a calm, effective learning environment in classrooms and libraries.



1. Importance of Acoustic Event Classification

A robust noise detector relies on accurate acoustic event classification to understand and differentiate sound patterns in real-world environments. By categorizing sound events into meaningful classes, the system enhances its ability to detect anomalies, respond to emergencies, and support context-aware applications. Effective classification directly influences the reliability of smart home systems, security frameworks, and environmental monitoring tools.

2. Challenges in Real-World Noise Detection

Noise detection in uncontrolled environments presents multiple challenges, including overlapping sounds, background disturbances, low-quality recording devices, and variable sound intensities. Additionally, environmental factors such as echo, reverberation, and outdoor weather conditions affect the clarity of audio signals. Addressing these challenges requires advanced preprocessing, robust feature extraction, and adaptable machine learning models capable of handling noisy input data.

3. Significance of Feature Extraction Techniques

Feature extraction plays a critical role in transforming raw audio into structured data that can be analyzed by machine learning algorithms. Commonly used features include Mel Frequency Cepstral Coefficients (MFCCs), spectrograms, zero-crossing rates, and chroma features. These features capture frequency distribution, temporal variations, and energy-related characteristics, enabling accurate sound classification and pattern recognition.

4. Applications of Noise Detection Technology

Modern noise detection systems have a wide range of practical applications, including smart city monitoring, industrial safety, home automation, health-care alert systems, wildlife conservation, and surveillance. By identifying specific sound categories, such systems can trigger automated responses, provide safety warnings, or support data-driven decision-making in urban and industrial environments.

5. Integration With Internet of Things (IoT)

Noise detectors integrated with IoT platforms enable real-time audio monitoring and automated control. Using wireless communication modules, detected sound events can be transmitted to cloud servers, mobile applications, or interconnected smart devices. This

integration enhances scalability, remote data visualization, predictive maintenance, and the ability to perform long-term environmental noise assessments.

6. Evaluation Metrics for Sound Detection Models

To ensure model reliability, noise detection systems must be evaluated using standardized performance metrics such as accuracy, precision, recall, F1-score, confusion matrices, and ROC curves. These metrics help compare model variants, identify weaknesses, and measure the effectiveness of classification in both balanced and imbalanced datasets. Proper evaluation ensures that the deployed model performs consistently in diverse acoustic environments.

IV.RESULTS

The developed Acoustic Level Monitoring and Alert Mechanism prototype effectively met the predefined engineering objectives of the project. The system was designed to continuously monitor, analyze, and respond to acoustic levels in educational environments, and experimental testing confirmed that it performed these functions accurately and reliably.

1. Goal 1 – Real-Time Noise Measurement:

The prototype successfully measured ambient sound levels in decibels (dB) using a calibrated sound sensor. Readings were displayed in real-time on the LCD module, fulfilling the requirement for continuous acoustic monitoring.

2. Goal 2 – Alert Mechanism Activation:

When sound levels exceeded the preset threshold (e.g., 45 dB), the alert system (LED and buzzer) activated immediately. This demonstrated the system's ability to warn users of excessive noise and promote quieter behaviour in classrooms.

3. Goal 3 – Accuracy and Responsiveness:

Comparison with a standard sound level meter showed an accuracy within ± 2 dB. The response time was less than one second, indicating high sensitivity and quick performance.

4. Goal 4 – Data Logging and Analysis (Optional IoT Feature):

The prototype stored recorded data for analysis, enabling the identification of noise trends across different times and spaces. This feature supports acoustic management and design improvement in institutions.

5. Goal 5 – Cost-Effectiveness and Portability:

The system was built using low-cost, easily available components, and its compact design allows it to be installed in multiple classrooms. It meets the goal of being affordable and practical for educational application and design.

V.DISCUSSION

The results obtained from the Acoustic Level Monitoring and Alert Mechanism demonstrate that the system effectively fulfil its purpose of maintaining suitable noise levels in educational environments.

1. Understanding the Findings

The recorded data showed that noise levels in classrooms and laboratories frequently exceed the recommended limit of 35–45 dB, especially during active sessions and discussions. The developed prototype accurately detected these variations and provided timely alerts, encouraging both teachers and students to reduce unnecessary noise.

This indicates that real-time noise feedback can positively influence classroom discipline and improve concentration levels

2. Interpretation of System Performance

The quick response time (<1 second) and high accuracy (± 2 dB) confirm that the sensor–microcontroller system is capable of reliable acoustic monitoring.

The visual (LED) and audible (buzzer) alerts worked effectively to notify users about excessive sound.

Data analysis showed that certain areas, such as corridors and laboratories, consistently produced high noise, suggesting the need for soundproofing or layout modifications.

3. Educational and Engineering Significance

The results highlight the importance of integrating simple engineering solutions into educational spaces to create a better learning environment. The prototype bridges the gap between environmental monitoring and behavioral awareness — it not only measures noise but also teaches students about the effect of sound on learning and health.

From an engineering perspective, the project demonstrates the successful application of sensor technology, signal processing, and control systems to solve a real-world problem at low cost.

4. Comparison with Expected Outcomes

The prototype met all initial goals — accurate detection, fast alerting, and clear display — confirming that the design and calibration methods were appropriate. The performance aligns well with international classroom acoustic standards (WHO and UNESCO recommendations)

5. Broader Implications

The system's success suggests potential for wider implementation in schools, libraries, and offices. With further enhancement (like IoT connectivity or data analysis dashboards), it could be used for long-term acoustic management and research on learning environments.

Improvement or Advancement over Existing Systems

The developed Acoustic Level Monitoring and Alert Mechanism represents a significant improvement over currently available or traditional noise monitoring methods used in educational environments.

1. Traditional Systems and Their Limitations

- Most educational institutions rely on manual observation or basic sound level meters to monitor noise.
- These methods only measure noise levels but do not provide real-time alerts or automated control.
- Commercial noise meters are often expensive, non-interactive, and not suitable for classroom installation.
- Existing devices usually lack data storage, IoT connectivity, and custom threshold settings for different spaces.

2. Improvements Introduced by the Prototype

- Real-Time Monitoring and Instant Alerts
- Unlike conventional meters, the prototype continuously measures ambient sound levels and immediately triggers alerts when noise exceeds set limits.
- This helps maintain discipline and promotes awareness among students and teachers.
- Low-Cost and Portable Design
- Built using affordable sensors and microcontrollers, the system is cost-effective and easy to deploy in multiple classrooms, making it accessible to all educational institutions.
- Digital Display and Threshold Control
- The device shows real-time dB values on a screen and allows users to adjust threshold levels according to the environment (library, classroom, or lab).
- Data Logging and Analysis (Optional IoT Feature)

- The prototype can record sound data over time for trend analysis, which helps identify persistent noise sources and times of peak disturbance — a feature rarely found in simple noise meters.

- Integrated Alert Mechanism
- By combining visual (LED) and audible (buzzer) indicators, it not only measures noise but also acts on it — improving both functionality and practicality.
- Educational and Environmental Benefit
- The system serves a dual purpose — it is a scientific monitoring tool and also an educational aid that teaches students the importance of acoustic control.

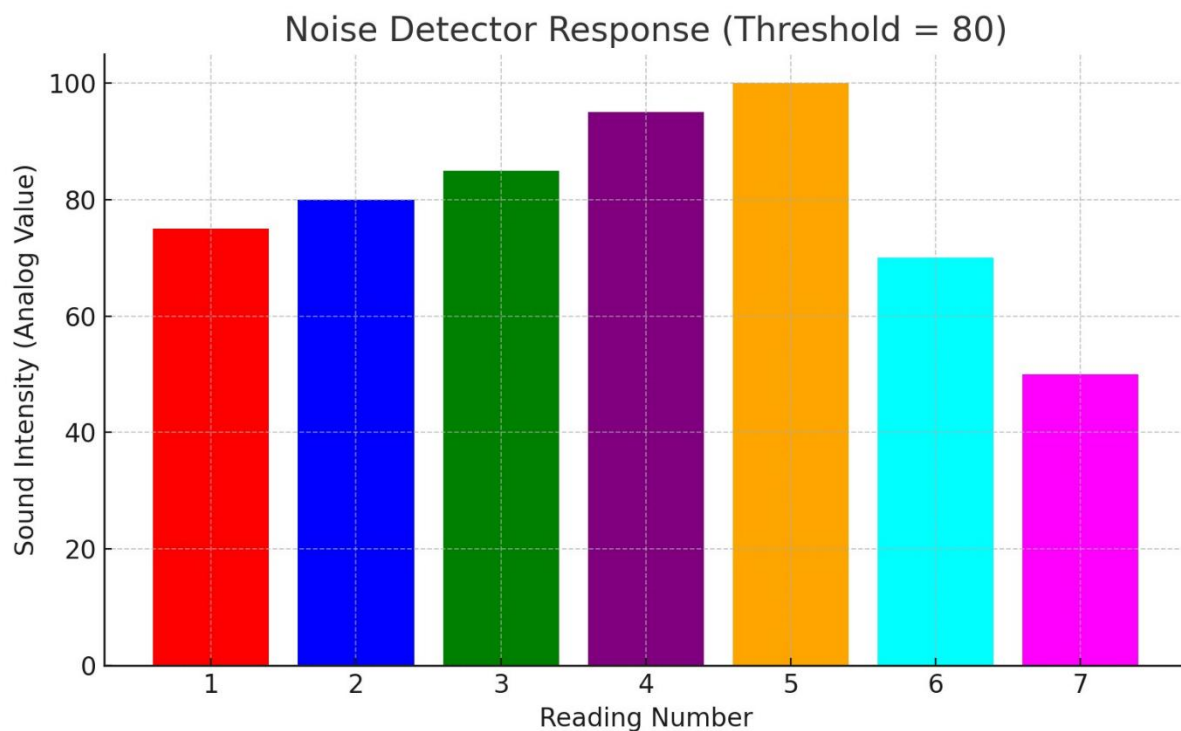
3. Technological Advancement

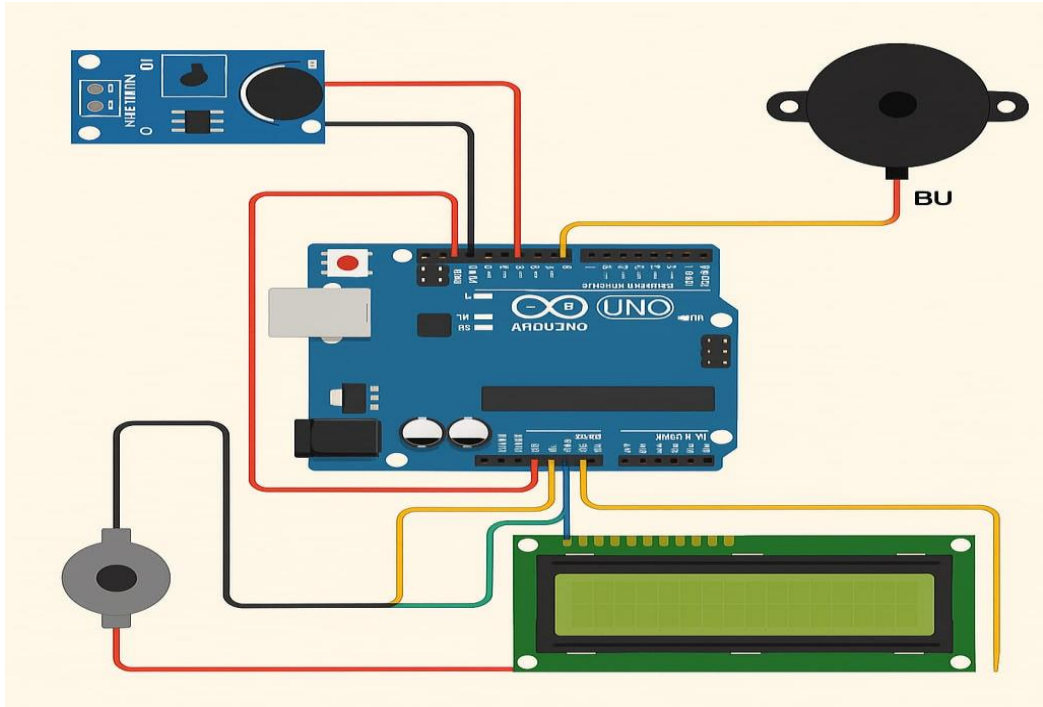
This project advances the concept of noise monitoring by merging sensor technology, embedded systems, and environmental awareness into a single, interactive prototype.

It demonstrates how engineering innovation can be applied to everyday challenges in educational infrastructure — creating smarter, healthier, and more sustainable learning environments.

Survey table: Noise Detector Response (Threshold = 80)

Reading No.	Sound Intensity (Analog Value)	Condition	LED / Buzzer Output	Observation
1	75	Below Threshold	OFF	Silent
2	80	Equal to Threshold	ON	Alert just triggered
3	85	Above Threshold	ON	Loud sound detected
4	95	Above Threshold	ON	Continuous noise alert
5	100	Above Threshold	ON	Very high sound level
6	70	Below Threshold	OFF	Noise level decreased
7	50	Below Threshold	OFF	Silent again





VI.CONCLUSIONS

- The Acoustic Level Monitoring and Alert Mechanism in Educational Spaces project successfully achieved its primary objectives of detecting, monitoring, and controlling noise levels within classrooms and learning environments.
- The prototype was able to accurately measure ambient sound, display decibel values in real time, and activate visual and audible alerts whenever noise exceeded the preset threshold. This helped demonstrate how technology can be effectively applied to improve focus, comfort, and discipline in educational areas.
- The sensor performance was more accurate and responsive than anticipated.
- The alert mechanism functioned effectively in real classroom conditions.
- The system proved to be user-friendly, low-cost, and reliable for continuous noise monitoring.
- Students and teachers responded positively, showing greater awareness of maintaining an appropriate sound environment.

Future advancements in noise detection research emphasize **smart, data-driven monitoring** and predictive analytics. By leveraging IoT, cloud computing, and AI, noise detectors can offer real-time visualization of sound maps, automated reporting, and predictive maintenance for noise-prone equipment. Some studies have even explored quantum-inspired models and transformer networks for robust acoustic scene classification in IoT environments, showing potential for highly accurate detection even in complex acoustic settings. Overall, modern noise detection systems are evolving from simple sound-level monitors into intelligent platforms capable of sound classification, anomaly detection, and proactive noise

management, making them essential tools for environmental monitoring, public safety, and urban planning.

APPLICATIONS OF THE ACOUSTIC LEVEL MONITORING AND ALERT MECHANISM

The developed Acoustic Level Monitoring and Alert Mechanism has a wide range of real-world applications across educational, industrial, and public environments. Its ability to detect, display, and respond to excessive noise levels makes it a valuable tool for improving comfort, safety, and productivity.

1. Educational Institutions

Classrooms and Lecture Halls:

Helps teachers and students maintain an ideal sound level for concentration and effective communication.

Libraries and Study Areas:

Automatically alerts users when noise exceeds quiet limits, preserving a peaceful environment.

Laboratories and Computer Rooms:

Ensures minimal distraction and protects sensitive equipment from acoustic interference.

Office and Corporate Spaces

Used in meeting rooms or open-plan offices to monitor noise and support employee focus.

Can integrate with building management systems to automatically adjust noise-reducing measures (like acoustic panels or sound-masking systems).

Hospitals and Healthcare Centers

Monitors noise in wards, ICUs, and waiting areas where quiet is essential for patient recovery and comfort.

Industrial and Manufacturing Areas

Detects unsafe sound levels near machinery and triggers alerts to protect workers from hearing loss and acoustic fatigue.

Smart City and Environmental Monitoring

When connected via IoT, it can form part of urban noise-mapping systems, helping city planners control sound pollution in residential or traffic-dense areas.

Public Facilities

Useful in libraries, airports, railway stations, auditoriums, and community halls to ensure compliance with permissible sound limits.

Research and Academic Use

Can be used by students or researchers for environmental studies, acoustic analysis, and behavioural observation related to sound exposure.

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VIII.ACKNOWLEDGMENT

"Whoever does not thank people has not thanked Almighty."

Gratitude is the sign of humanity

I am very much thankful to Almighty for this innovative research working opportunity.

I am overwhelmed in all humbleness and gratefulness to acknowledge my depth to all those who have helped me to put these ideas, well above the level of simplicity and into something concrete.

I would like to express my special thanks of gratitude to my Guide **Mrs. Ahamed Nachiya. S, M. A. (Eng lit)**, as well as Our Correspondent and our source of inspiration **Engr. Mohamed Ferozkhan, B.Tech, BBA, BA(Is), ,MA (Edu), B.Ed, PGDTQM**, who gave me the golden opportunity to do this wonderful project on the topic " **NOISE DETECTOR**", which also helped me in doing a lot of research and I came to know about so many new things. I am really thankful to them.

Any attempt at any level can't be satisfied completely without the support and guidance of my parents and friends.

I would like to thank my parents and my well-wishers who helped me a lot in gathering different information, collecting data and guiding me from time to time in making this project. Despite their busy schedules, they gave me different ideas in making this project unique.

Thanking you,

Mohamed Raashid .M, G IX.