SOUNDSENSE

By Team Soundsense

1.Introduction

Environmental noise plays a critical role in human comfort, concentration, and overall well-being. Continuous exposure to elevated background noise can lead to stress, fatigue, reduced productivity, and long-term health impacts. In many everyday environments, such as shared study spaces or indoor rooms, noise levels fluctuate subtly, making it difficult for individuals to recognize when sound becomes disruptive.

The SoundSense project addresses this issue by capturing ambient sound levels directly from the physical environment and translating them into understandable visual and physical feedback. The system emphasizes real-world sensing, allowing users to see and react to changes in sound intensity as they occur.

From a physiological perspective, the project supports preventive awareness. Rather than reacting to extreme noise, users can proactively adjust their behavior or surroundings before sound exposure becomes harmful or distracting.

2.Technical Solution and Architecture

2.1 Hardware-Centered System Design

My main responsibility in the SoundSense project was the hardware layer, including:

- Arduino setup
- Sound sensor integration
- Potentiometer calibration
- LED feedback
- Reliable serial data transmission

The hardware acts as the foundation of the system, as all digital processing depends on the accuracy and stability of sensor readings.

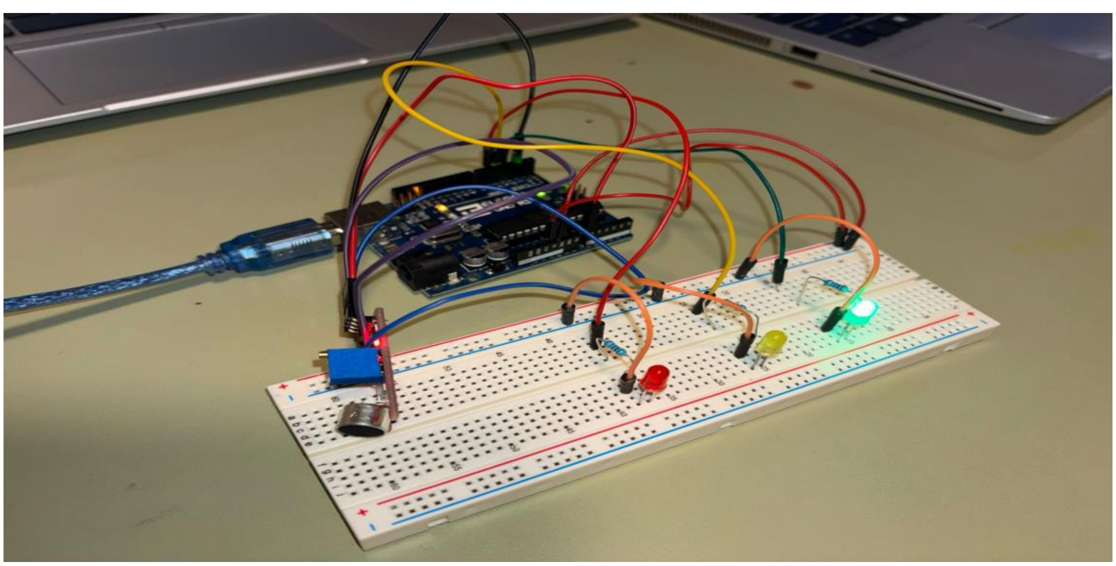

Figure 1. showing Arduino setup and the LED feedback.

2.2 Arduino, Sensors, and Components

The core of the hardware setup is an Arduino microcontroller connected to:

- An analog sound sensor module for measuring ambient sound intensity
- A potentiometer for sensitivity adjustment
- LEDs for immediate visual feedback

The sound sensor continuously samples environmental noise and produces analog voltage values. These values are influenced by environmental conditions and sensor sensitivity, making calibration essential.

The potentiometer allows dynamic adjustment of thresholds, enabling the system to adapt to different environments such as quiet rooms or noisier spaces. LEDs provide instant physical feedback, allowing users to recognize sound level changes without relying solely on the web dashboard.

2.3 Calibration and Signal Stability

One of the most important hardware challenges was ensuring stable and meaningful sensor readings. Raw sound sensor output can be noisy and sensitive to electrical interference.

To address this:

- Thresholds were carefully tuned using the potentiometer
- Sampling intervals were optimized to balance responsiveness and stability
- LED behavior was mapped to defined sound ranges

This calibration ensures that the backend receives consistent data and that the frontend visualization reflects real environmental changes rather than random noise.

2.4 Integration with Backend

The Arduino sends formatted readings over serial communication to the backend. Each message follows a simple structure, making it easy for the backend to parse and process.
Although my focus was hardware, close coordination with the backend development was necessary to ensure:

- Compatible data formats
- Correct sampling rates
- Reliable communication

This collaboration highlights the interdisciplinary nature of the project, combining embedded systems with modern web technologies.

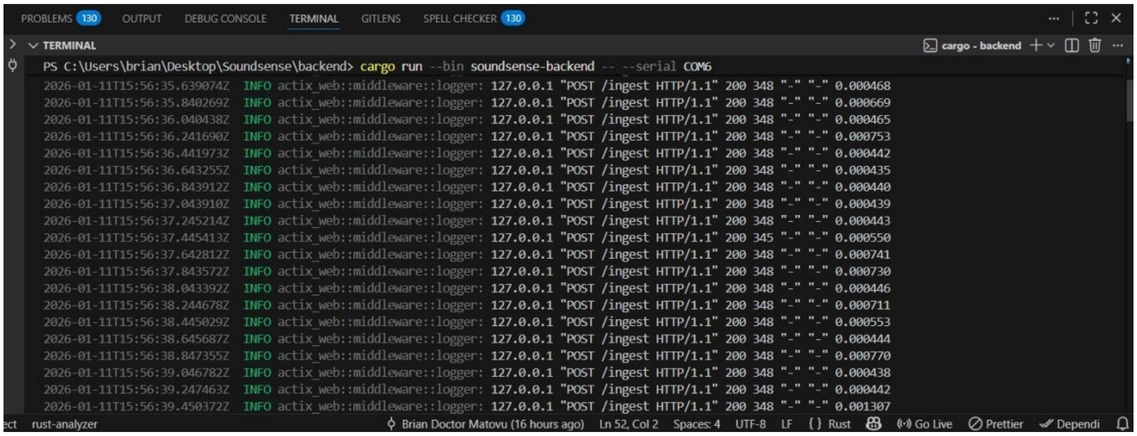

Figure 2. showing backend logs from the sensor via a serial port.

3.Results and Analysis

Hardware testing demonstrated that the system reliably detected changes in ambient sound levels across different environments. Actions such as speaking, clapping, or background noise were immediately reflected in sensor readings and LED behavior.

3.1 Observed Performance

The potentiometer proved essential for achieving stable operation. Without calibration, the sensor output fluctuated excessively. With proper tuning, noise was reduced and meaningful patterns emerged.

LED indicators responded consistently to threshold crossings, confirming that the analog-to-digital conversion and logic mapping were functioning correctly.

3.2 Interpretation of Hardware Results

The results show that low-cost hardware components can effectively capture physiologically relevant environmental data when properly calibrated. The combination of potentiometer control and visual LED feedback significantly improves system reliability and user interaction.

From a system perspective, stable hardware output is crucial. Backend processing and visualization quality depend directly on sensor reliability. The successful hardware performance therefore validates the overall system design.

3.3 Broader Perspective

The hardware layer demonstrates how physical sensing can be integrated into larger digital ecosystems. By producing consistent, calibrated data, the system becomes suitable not only for visualization but also for future analytical and health-related applications.

4.Individual Responsibility, Learnings, and Challenges

4.1 My Responsibility

I was responsible for the complete hardware setup, including Arduino configuration, sensor wiring, potentiometer calibration, and LED feedback design. I also contributed to Git version control together with my project partner.

4.2 Individual Learnings

Through this project, I gained hands-on experience with:

- Embedded systems and sensor integration
- Calibration techniques for analog sensors
- Translating physical signals into digital data
- Coordinating hardware development with software teams

4.3 Individual Challenges

Key challenges included:

- Reducing sensor noise and instability
- Finding meaningful threshold values
- Ensuring consistent serial communication

Addressing these challenges strengthened my understanding of how physical systems interact with digital platforms and highlighted the importance of careful calibration in sensor-based projects

5. Conclusion

The SoundSense project successfully demonstrates how calibrated hardware sensing can transform ambient environmental noise into meaningful, real-time feedback. Through careful integration of sensors, calibration mechanisms, and visual indicators, the system provides reliable data that supports user awareness and proactive noise management. This project highlights the effectiveness of low-cost embedded systems in real-world monitoring applications.