

Lab 1 Outline - Team Sapphire
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6 October 2025
Version 1

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1. Introduction

1.1. Societal Problem

Living in shared spaces such as apartments, dormitories, and townhomes often creates challenges, particularly when noise becomes a source of conflict. Loud music, late-night gatherings, or even ordinary daily activities can quickly turn into major frustrations for tenants. In fact, noise remains one of the leading causes of tenant complaints. A major issue with these disputes is that noise complaints are typically based on personal accounts. This makes them subjective and often unreliable, which places property managers in a difficult position. Without objective evidence, they must make judgment calls that may not feel fair to either party. The absence of neutral proof not only leads to inconsistent resolutions but can also increase tensions between neighbors.

The problem is not limited to inconvenience. The American Public Health Association has warned that “chronic noise, even at low levels, can cause annoyance, sleep disruption, and stress that contribute to cardiovascular disease, psychological disorders, and premature mortality” (APHA, 2021). Recent studies further show that long-term noise exposure negatively impacts mental health, contributing to anxiety, depression, and decreased resilience. Tenants therefore not only suffer from frustration but also face health consequences when exposed to ongoing disturbances.

Despite this, renters have few tools to defend themselves against false accusations or to provide evidence when they are being disturbed. Property managers likewise lack

reliable methods to separate legitimate grievances from exaggerated claims. As a result, there is a growing demand for objective, privacy-respecting noise monitoring solutions that improve both the tenant experience and conflict resolution processes.

1.2. Solution - Sapphire Sound Monitor

The Sapphire Sound Monitor is designed to fill this gap by providing a software-enabled, automated noise monitoring system. Its primary purpose is to replace subjective claims with verifiable, unbiased data while still protecting tenant privacy. The system uses a noise sensor to measure sound intensity in decibels without recording any audio content, ensuring that personal conversations remain private. When noise levels surpass a set threshold for too long, the system automatically logs the event and generates a timestamped report. These reports are shared with property managers, allowing them to address complaints fairly.

For tenants, the solution is equally empowering. They can access their own noise history through a mobile or web application, receive real-time alerts when they are being too loud, and even participate in an optional rewards program that encourages quieter living. By combining objective monitoring with positive reinforcement, the Sapphire Sound Monitor creates a more cooperative and respectful shared living environment.

2. Sapphire Sounds Product Description

Sapphire Sound is a mobile and web-based application paired with a compact noise sensor. The sensor measures the intensity of sounds but does not record any audio, ensuring privacy protection. If high noise levels persist beyond a set duration, the system generates a timestamped report that documents the disturbance. These reports provide property managers with objective data to fairly resolve complaints, reducing the reliance on subjective accounts.

Meanwhile, tenants benefit from the ability to view their own noise histories, receive alerts when their activity exceeds acceptable levels, and earn rewards for maintaining compliance. By shifting conflict resolution from personal opinion to factual evidence, Sapphire Sound fosters more peaceful community living.

2.1 Key Product Features and Capabilities

Sapphire Sound introduces several key features that distinguish it from traditional approaches. Its monitoring process is privacy-first, since it measures only decibel levels and never records audio content, ensuring that tenants' conversations remain private. The system also promotes data-driven dispute resolution by replacing subjective claims with timestamped logs that can serve as reliable evidence for both tenants and managers. In addition, Sapphire Sound encourages respectful community behavior through its reward system, which recognizes tenants who maintain acceptable noise levels. Real-time alerts are another important feature, allowing tenants to correct their noise levels before violations escalate. If problems persist, the system escalates reports to property

managers for further action. Together, these capabilities provide a fair and privacy-conscious method of addressing noise issues in shared spaces.

2.2. Major Components (Hardware/Software)

The Sapphire Sound system is built on both hardware and software components that work seamlessly together. On the hardware side, the system relies on a Raspberry Pi Zero 2 W, which acts as the controller that collects data from the noise sensor and transmits it wirelessly. This function is supported by the Infineon CYW43439 Wi-Fi chip, which enables secure network connectivity. An I2C decibel sound level meter measures real-time sound intensity and connects to the Raspberry Pi using the I2C protocol. The Raspberry Pi then continuously samples noise levels, timestamps them, and transfers the data securely over WiFi.

On the software side, the frontend is built with React.js and provides both web and mobile interfaces, hosted on Firebase, to give tenants and property managers access to logs, reports, and alerts. The backend, developed in Node.js and hosted on Render.com, handles sensor data ingestion, user authentication, noise analysis, and the logic for alerts and reports. A PostgreSQL database stores timestamped logs, user data, noise patterns, and reward tracking, ensuring all information remains organized and accessible. Development and version control are managed through GitHub, which supports collaboration and continuous integration. This combination of hardware and software ensures that Sapphire Sound is scalable, reliable, and user-friendly.

3. Identification of Case Study

The primary users of Sapphire Sound are tenants and property managers. Tenants benefit by monitoring their own noise levels, avoiding disputes, and even earning rewards for compliance. Property managers gain a fair and consistent way to resolve complaints without relying solely on subjective accounts. This is especially valuable because noise complaints are among the most frequent issues in multi-unit housing. Without objective data, disputes can escalate into retaliation, unfair blame, or long-term conflict.



By equipping property managers with reliable, privacy-compliant tools, Sapphire Sound allows them to address chronic noise issues while maintaining fairness and transparency. At the same time, tenants gain the ability to prove disturbances or defend against false accusations, improving trust and communication between neighbors and management. Ultimately, Sapphire Sound supports a more peaceful and cooperative living environment for everyone involved.

4. Glossary

- dB (Decibel): A unit to measure the intensity of sounds.
- Noise Event: An occurrence when decibel thresholds are reached for a specific duration. Used for reporting.
- Noise Sensor: A physical device that monitors sound levels without recording audio.
- Report: A structured report generated by the system, detailing the noise event.
- Threshold: A predefined decibel level, which if exceeded, will trigger a noise event
- Tenant: A resident or occupant of a shared or multi-unit housing space using the system to manage and monitor noise activity.

5. References

American Public Health Association. (2021, October 25). *Noise as a public health hazard*.

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