1 Introduction

1.1 Objective
Maintaining acceptable noise levels in crowded areas such as apartments has always been an issue. Some people like to live in quiet environments and are easily disturbed by their neighbors. Some scenarios could include when a neighbor is having a party or playing an instrument. This can be very distracting for their neighbors especially in apartments with thin walls. Most apartments don’t control the noise well.
We need a product for landlords to maintain a quiet environment so that tenants will have a good living experience. We need something to tell and warn our noisy neighbors when they are being too noisy especially during certain times of the day such as late night. If they keep being noisy after several warnings, the device will be able to quickly resolve the issue by automatically notifying the device administrator or landlord.

Our goal is to create a portable and easy to use device that can go in rooms in the apartment and can warn people indoors when they are going above the acceptable noise levels. We want this device to very customizable and adjustable by offering the landlord many options in how they control their quiet environment. Some parameters we plan to let the landlord adjust are the acceptable decibel levels, the time of days where certain thresholds are set, the length of time that a certain decibel level can be maintained before a warning is sent out, and the amount of warnings to the person creating the noise until the device administrator is notified.

1.2 Background
Usually when a person experiences issues with their neighbors being to loud they have a couple of options. You can go directly to your neighbor and inform them that they are being too loud. However, this usually can cause some issues because it can create hostility between the neighbors and sometimes the neighbors just don’t listen outright. This shouldn’t be the responsibility of tenants to try to quiet down their neighbors. The second option is to go to your landlord to complain, but not only does this take a lot of your time and energy, but also you don’t have any evidence to backup your claim. Also another issue is that sometimes the person who is creating too much noise is not even aware that they are disturbing their neighbors. The device will solve all these problems by creating an automated system that avoids neighbor conflicts, saves time, and lets the noise maker know that they are being too loud. The device will also be affordable so that landlords can place it in many rooms.

1.3 High-Level Requirements
- The device has to be as low cost as possible (under $50) so that the landlord can put it in the many apartments and rooms in the building
- The device should be able to operate on lithium ion battery power for around 3 days and can be able to charge in an outlet
- The device should be able to connect to a phone, possibly with an app through it's wifi subsystem (2.4Ghz or 5Ghz)
- The device should have adjustable thresholds for noise level and time of consistent noise

2 Design
The device should have 5 different subsystems to make it work which is a power supply, a noise sensor, control unit, alert system, and wifi module. The power supply will make sure the device can be powered for 3 days with lithium ion batteries, and a power adapter to charge the batteries. The control unit accepts the noise levels and adjustable parameters from the wifi module controls the alert system. The alert system receives the signal from the control unit to know when to alert. The wifi module will connect to the phone via wifi and output signals to the control unit.
2.1 Power Supply
The power supply will keep the device powered continuously which is will be at 3.7V with the voltage regulator

2.1.1 Lithium ion charger
This will charge the battery using a power adapter that connect to a wall outlet. The charger should be able to fully charge the battery within 2-4 hours.
Requirements: The device should charge the battery in 2-4 hours

2.1.2 Lithium ion battery
The lithium ion battery should be able to keep the device powered for around 3 days without charge.
Requirement: Should provide 300 mA at 3.7V for 72 hours

2.1.3 Voltage Regulator
The circuit will give 3.7V to the rest of the device
Requirement: The voltage regulator must stabilize the voltage at 3.7V from a 3.7V source

2.2 Wifi module
The module can access a WiFi network to get the parameters set by the device administrator

2.3 Noise Sensor
This module will measure decibel values very accurately.

2.3.1 Microphone array
The microphone array will contain multiple microphones in different directions so that it can sense sound omnidirectionally.
Requirements: It should be able to detect noise levels accurately from 5 meters away in every direction.

2.3.2 Amplifier
Certain microphones may require for this to work. Subject to change.

2.3.3 ADC
The analog to digital converter will convert analog signals from microphones to digital signals to be used by the microcontroller.
Requirements: sampling rate of 44.1kHz and output bit rate of 8kbps.

2.4 Alert System
Will contain a combination of speakers and LED lights

2.4.1 Speakers
The speakers will create some kind of sound alarm when given the signal by the control unit
Requirement: Speak can output up to 85 dB sound alarm.

2.4.2 LED lights
The lights will flash in some sort of pattern to let the user that they are creating noise
Requirement: The LEDs must be noticeable from up to 10 meters away

2.5 Control Unit
The control unit will handle all the calculations of when to set certain thresholds of sound levels, the time of the day, when to give warnings, and when to notify the device administrator

2.5.1 SD card
The SD card will provide the memory needed for the microcontroller to operate including storing the adjustable parameters that the device administrator can change
Requirements: Should be able to hold at least 512MB

2.5.2 Microcontroller
Should be able to communicate with the wifi module as well as the alert system
Requirements: Be able to handle basic use cases as mentioned above.

2.6 Risk Analysis
It is difficult to calculate the accurate noise level in decibels.
It is hard to make the WiFi module work well to communicate with both user’s phone and the control unit, and we need to prepare for it early.
It is significant to make sure that the battery has the enough voltage for every component (and scientific allocation of electricity inside each module).

3 Safety and Ethics
Some ethics issues is that landlords can unfairly monitor their tenants noise and this can create privacy concerns. People might think that these devices breach their privacy rights because they will always be listening, just like people nowadays are paranoid of computer webcams spying on them or how social networks are using their data. This device can be seen as another type of this data collection. Landlords can possibly set threshold levels to extremely low and unfair values so that tenants cannot do any type of activities that involve any types of noise. It can cause tenant and landlords relationships to be very bad since typically tenants do not like to have to many restrictions over properties that they are paying for.
For the project, Lithium ion batteries can also have safety controls as the batteries can possibly explode or emit harmful chemicals if not disposed of properly.