Door-Knocking Alarm for the Hearing Impaired

ECE 445 Project Proposal

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1. Introduction

1. 1 Problem

People who are deaf or hard-of-hearing can find it difficult to tell when someone is knocking at their door. This can lead to important notifications being missed and frustration for both parties.

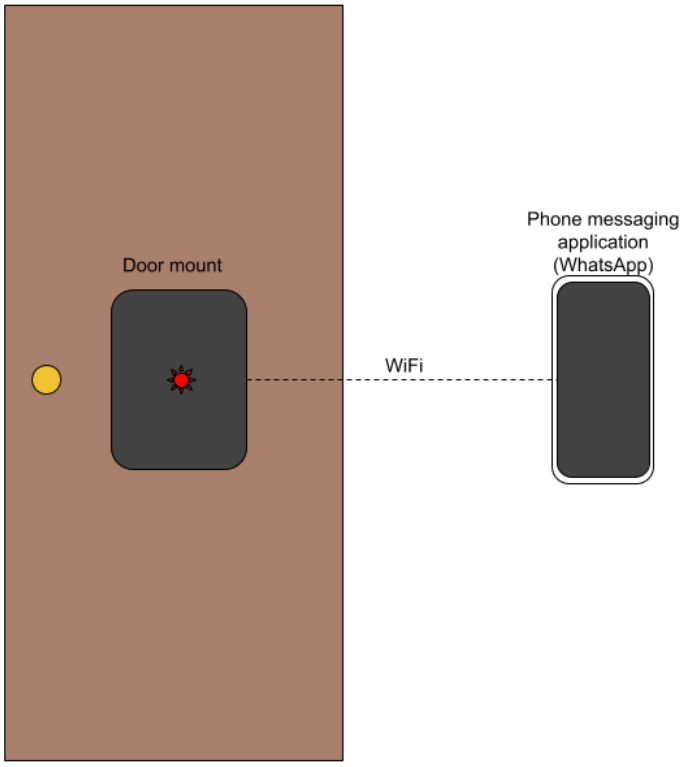
While there are plenty of alarms on the market that show some visual indicator (such as a light) when a doorbell is rung, there is a gap in the market for visual alarms for people with hearing impairments who do not have doorbells. For example, people living in dorms, apartment units (especially across college campuses), and individual office rooms often don't have doorbells installed. These spaces are often rented and so permanent installations are not feasible.

1. 2 Solution

We propose a device that can detect when someone is knocking and send an alert. The design will use batteries for its power supply and will be easily attachable to most doors. Running off of batteries will make it more accessible as not all doors have an electrical outlet readily available.

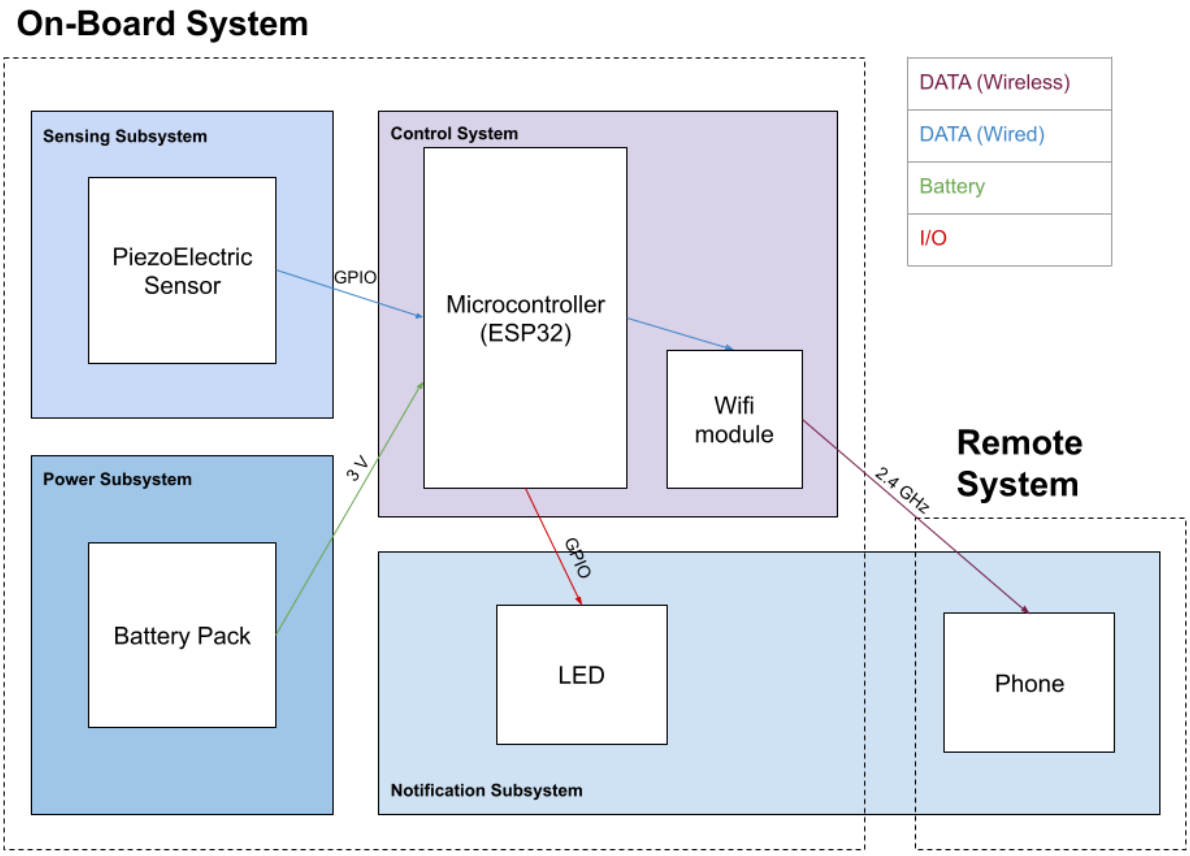
The Piezoelectric sensor will specifically be aiming to detect vibrations through the door. The differentiation between knocking vibrations and vibrations that may cause vibrations through the door (for example, lots of people running past the door in a dorm setting) will be determined by testing a range of vibrations classifiable as knocking. After the alarm is triggered, it will then send an alert to the user's phone, and also emit a bright light.

1. 3 Visual Aid:



2. Design

2. 1 Block Diagram



2. 2 Subsystem Descriptions

2. 2. 1 Power

The power subsystem will run off a 9V battery and voltage will be converted to appropriate voltages as required by the other subsystems.

Requirement 1: The battery must be easily accessible, so that the user can replace the batteries without issue.

2. 2. 2 Piezoelectric Sensor

This subsystem will consist of the Piezoelectric sensor picking up on vibrations from the door that the device is mounted on. The detected frequency of vibration will be filtered and

compared to tested threshold and after it has been sent for processing by the microcontroller. The frequency range that we estimate to detect for a door knock is between 0 to 1 kHz [1].

Requirement 1: Send data to the ESP32 only when the vibrations are in the threshold

2. 2. 3 LED and Phone Notification System

The notification receiving system consists of two parts - an LED and a phone with WhatsApp. The microcontroller will send a notification to the phone through WhatsApp when the door-knocking alarm is triggered along with lighting an LED, turning it off after a short period of time. The LED system will be directly connected to the door-knocking alarm and will receive a signal from the microcontroller.

Requirement 1: The LED will light up and the phone will receive a WhatsApp notification when the door-knocking alarm is triggered and only then.
Requirement 2: Power supplied to the LED should not result in a loss of power and functionality to the sensor system.

2. 2. 4 Control

The control subsystem consists of the microcontroller (ESP32) and its connections to other components (PCB) as the main controller of how the subsystems interact. The microcontroller is in charge of taking the frequency/vibration data from the sensor subsystem and comparing it to a tested and validated threshold, deciding whether or not to send notifications using the above notification subsystem.

Requirement 1: Correctly determine whether vibrations are background noise or knocking.

Requirement 2: Communicate with WhatsApp to deliver notification and light the LED.

2. 3 Tolerance Analysis

The success of the project is dependent on the capability of the piezoelectric sensor to be able to accurately detect when someone is knocking on the door. This means that the project is dependent on a piezoelectric sensor's frequency detection range corresponding to the frequency range of door knocking. According to a database of information on everyday sounds constructed by Leila Abdoune and Mohamed Fezari, door knocking produces frequencies in the range of up to 1 kHz, with most of the knocking noise falling around the 0.2 kHz range [1]. The piezoelectric sensors on the market are capable of detecting up to 1 kHz of vibration frequency, thus door knocking can be reasonably said to be detectable using the mentioned parts and mechanisms listed in this proposal.

3. Ethics and Safety

Our main ethical concern with this project is in Section 7.8.9 of the IEEE Code of Ethics, which pertains to the protection of property of other people [2]. One of the main purposes of our device is to allow people to have an easily installable, non intrusive device to use on other people's property. Therefore, our team will ensure a design that will not lead to permanent damages on whatever door surface it is mounted onto. Furthermore, it will be important to use proper battery and power safety techniques to prevent overheating or damaging the LEDs.

Regarding safety, since our device does house electrical components, we will make sure that these components are properly enclosed. In addition, our project will include an LED component, which will be used to notify the user of knocking. We will ensure a safe level of brightness and consistency to avoid photosensitive seizures.

References

[1] Mohamed Fezari. “Everyday Life Sounds Database: Telemonitoring of Elderly or Disabled.” ResearchGate, March 2014, https://www.researchgate.net/publication/273187267_Everyday_Life_Sounds_Database_Telemonitoring_of_Elderly_or_Disabled?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoiX2RpcmVjdCJ9fQ [Accessed: Sep. 13, 2023].

[2] IEEE code of ethics. IEEE Policies, Section 7 - Professional Activities. https://www.ieee.org/about/corporate/governance/p7-8.html [Accessed Sep. 14, 2023].