ECE445

SENIOR DESIGN LABORATORY
PROJECT PROPOSAL

MOBILE DEPLOYABLE SMART DOORBELL

Team No. 16

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1 Introduction

1.1 Problem

As a college student living in a dorm/apartment complex, the absence of a doorbell poses inconvenience for both myself and my visitors, such as my friends, neighbors, or anyone who would come to my house. My room is located far from the entrance; therefore, every time they knock on the door, I can't respond promptly.

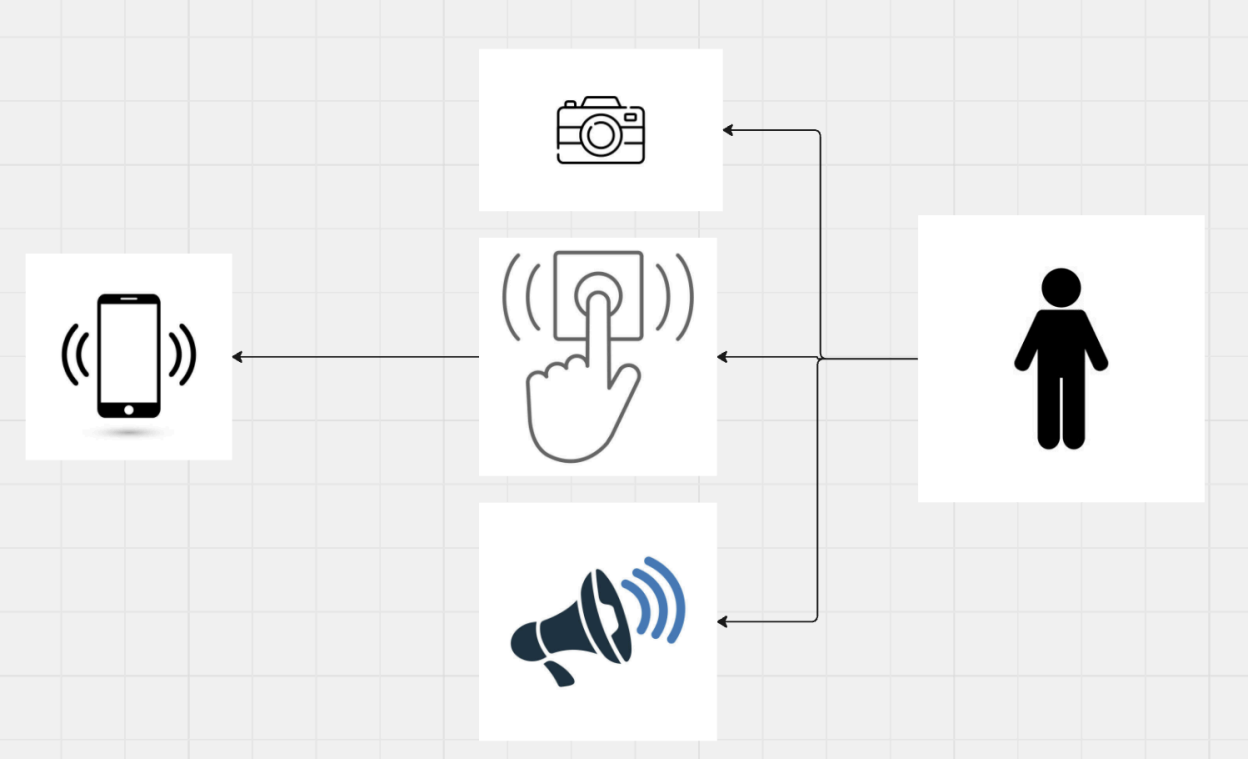
Moreover, regular doorbells will fail to notify me if I am either too far from the door or there are barriers between. In scenarios where I am taking a shower, at the balcony, taking phone calls, and playing video games, I am unable to hear anything outside of my enclosed environment.

1.2 Solution

Our project is a small, smart doorbell that can be easily deployed and notify the resident via their phone. The doorbell will be connected to the internet and to the resident's phone. When a visitor presses the doorbell, the resident will be notified via phone, which is almost always with the resident in this technological society. Therefore, the resident can be notified in real-time regardless of where they are. This solves the issue of not having the need to hear "physical" sound from a regular doorbell located outside the door. With phones being present at almost all times during our everyday's lives, the resident would be notified via real time, bypassing anything in between.

Furthermore, our doorbell will support a variety of features such as voicemail and video recording. The resident can respond to their visitors despite not being at home and in

many different circumstances.



1.3 High Level Requirements

1.3.1 Audio and Video Transmission Quality

Internet transmission will be one of the important features of our device. We hope to achieve grayscale video streaming with the resolution of 1280*720p and with 12 frames per second. As for audio, we aim to have the capability of transmitting audio with an 8kHz sampling rate and 8-bit bit depth.

1.3.2 Phone App Latency

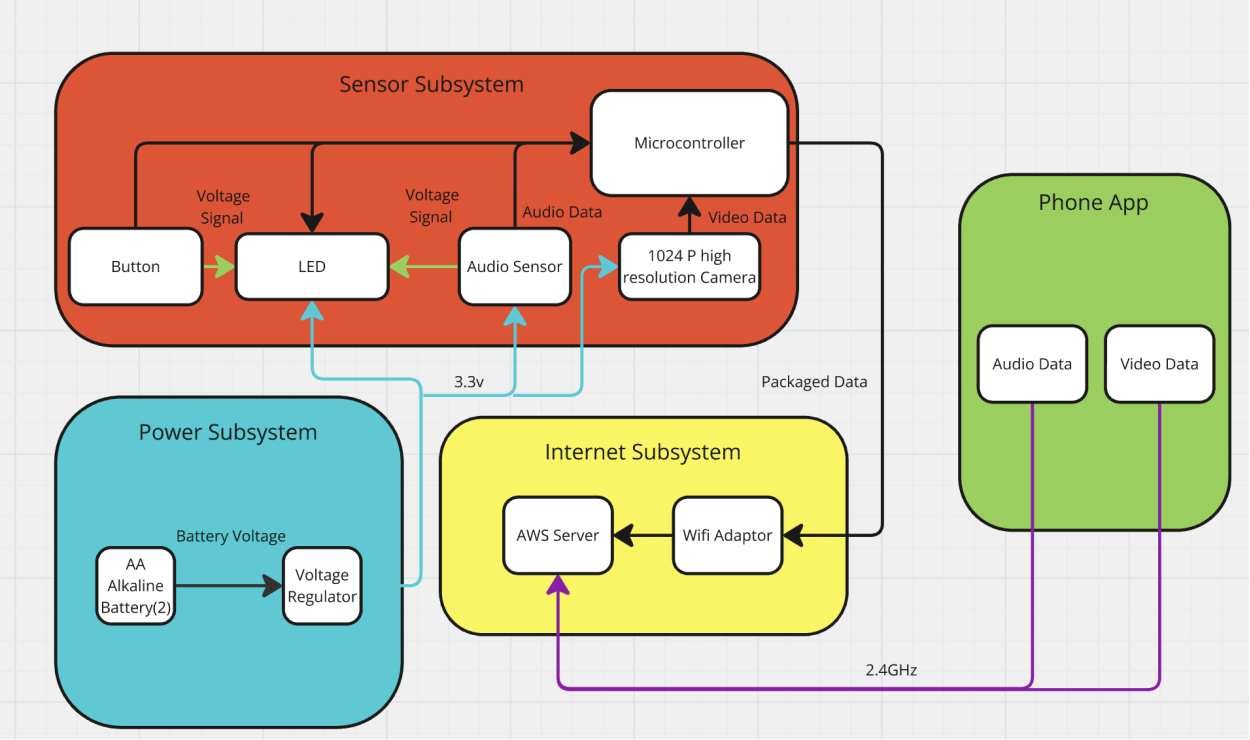
In order to visually show the video data and play audio in real time, our design aims to achieve a data latency of less than 1 second.

1.3.3 Weight

To enable convenient deployment and carrying of our project, the weight of the whole module needs to be light. The project, including enclosure and batteries, will not weigh over 2 kilograms.

2 Design

2.1 Block Diagram



2.2 Subsystem Overview

We divided our product into four subsystems: Sensor subsystem, Power Subsystem, Internet Subsystem, and a Phone App. Power subsystem provides a direct current power to the sensor and the WiFi adaptor in the internet subsystem. The sensor subsystem accepts inputs from a person, including pressing the button and recording video and audio. These data are passed to the internet subsystem and the adaptor sends these data to

the AWS server. Meanwhile, the Phone App side will constantly retrieve data from the server to check if any new signals are coming, so that it can visualize the video data and play the audio data.

2.3 Subsystem Requirements

2.3.1 Sensor Subsystem

We have several sensors in our doorbell: a microphone, a camera, a button, an LED, and a microcontroller. We want our camera to have enough resolution to tell the face of the person answering the door and the audio legible enough to recognize words. Aside from those, the haptics of the button should also be clear enough to hint to the user. Additionally, we want an LED to indicate the microphone is currently recording. Finally, we will need a microcontroller to manage all the components and organize the package. Overall, we strive to look for low-cost, low-power, but effective components.

2.3.2 Internet Subsystem

Internet transmission will be one of the important features of our device. Instead of setting up a server by ourselves, we will have to send our packet through a WiFi chip to a cloud service platform (e.g. AWS, Azure) so that users' phones have access to the audio and video data from the doorbell. We at least have to make the doorbell connect to WiFi and send data to a server with a given IP address. The transmission rate is further discussed in the high-level requirement.

2.3.3 Power Subsystem

We need sufficient power and low-power-consuming components in our doorbell since we don't want the users to change batteries frequently. More specifically, we will try to implement a AAA battery and regulate the voltage with a voltage regulator. Our goal is to let it sustain one month without replacing new batteries.

2.3.4 Phone App

There are several requirements for our phone application. We are aiming to develop an iOS application since iPhone users take a majority portion of people and all team members have an iPhone. Hence, we will design the application in XCode. Firstly, we need to be able to send a notification (a pop-up notification) whenever the button of the doorbell is pressed. To achieve this, we will have to connect the phone with the internet to get a real-time signal from another server. On top of that, we will also have to design a user interface that includes a panel playing the video from the camera and a hint about audio playing.

2.4 Tolerance Analysis

The major issue of our project falls into internet connection. Streaming video from a microcontroller to a phone takes a lot of bandwidth, and both the transmission rate of the chip module and the connection of the WiFi of the phone and our PCB are not guaranteed to be stable enough. Since the most iconic feature is based on the internet connection system, achieving enough bandwidth and stability is our core task of realizing our project.

3 Ethic & Safety

Our group's action complies with IEEE Code of Ethics adopted by the IEEE Board of Directors and incorporating revisions through June 2020. As the advancement of technology can greatly alter one's life, all teammates agreed to hold themselves to the highest ethical standard during the development of the project. These includes but not limited to the following points:

3.1 Treating all persons with fairness and respect

As specified by the code of Ethic, it is important "[t]o treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring

others."(*IEEE*) In order to achieve this, our group will hold a weekly meeting reflecting on our collaboration and communication method to ensure that all teammates are treated with fairness and respect. Moreover, we will also make sure all opinions from all people are evaluated without bias.

3.2 Ensure IEEE Code is upheld.

To ensure the IEEE Code of Ethics is upheld and complied by all team members (*IEEE*), we have a special channel in our discord group dedicated to reporting any violations against the code anonymously. A special meeting will be held once any violations are reported, and our team will take immediate action to amend the violation.

3.3 Safety

Here are some safety concerns of utilizing our doorbell both in the aspect of hardware and software. Each aspect of safety concern will be addressed in detail in the following paragraphs.

3.3.1 Hardware Safety

To prevent other people from installing malicious programs onto our microcontroller, we are enclosing the entire structure with a 3D-printed case. We will also let the users know to not use a damaged doorbell to minimize the risk of using a doorbell with different settings. In terms of battery safety, we are using dry batteries with a voltage regulator to minimize the risk of fire and damage to both the module and other property.

3.3.2 User Security and Privacy

In order to protect against malicious attacks from other people and prevent data leak of the customers, we choose to send data from the doorbell to a server and read data in the server at users' ends. This method doesn't expose the user's phone IP address and our data encoding method will prevent data leakage.

4 References

IEEE - IEEE Code of Ethics, www.ieee.org/about/corporate/governance/p7-8.html. Accessed 19 Sep. 2024.