Team Antiprocrastinator Design Document

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Introduction

Problem

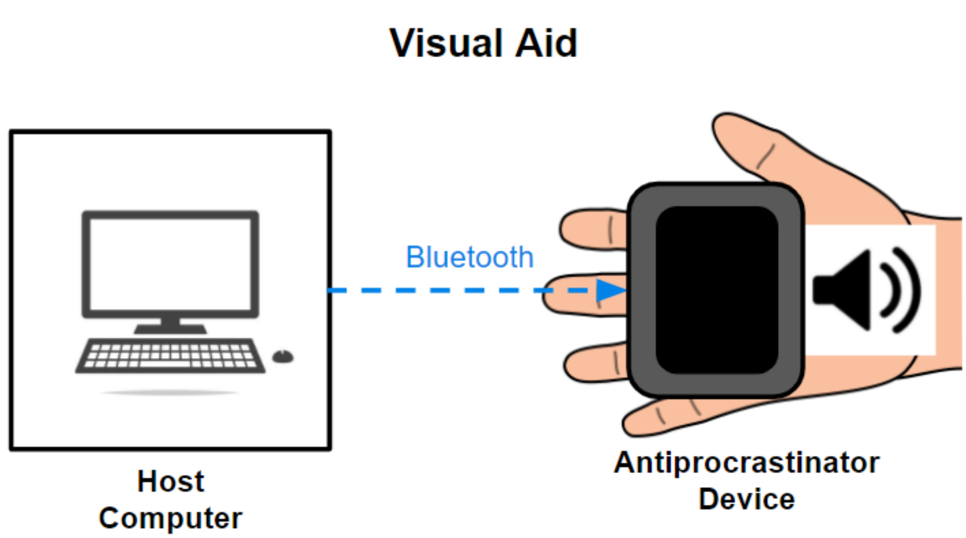
Procrastination has been a huge hurdle in the lives of many students and workers. While some people have the self-discipline to get work done, many people like our group aren't great at staying focused. Some of our members have participated in procrastination and have also had firsthand experience of the consequences of procrastination (e.g. all-nighters, lower grades). Many procrastinators like ourselves push school and work to the side and instead pursue various forms of entertainment, such as computer games or internet videos, in order to avoid doing work. This forces procrastinators to put off their assignments until the deadline, to which they are forced to cram a few days' worth of work into a few hours, which consequently means that the procrastinator will be physically and mentally exhausted, and the work completed will be of mediocre quality at best.

Solution

The solution is to make procrastinating harder. Specifically, we will be hindering the access of any websites or computer programs that the user has blacklisted. There are browser extensions that can block websites, but those just leave the user waiting in anticipation until their websites are unblocked when the timer ends. Our goal is to use a wireless, battery-powered watch with an integrated speaker that, upon receiving a signal from the computer that the user is using blacklisted sites/programs, continuously plays an annoying sound until said sites/programs are closed. This watch consists of a few components in order for it to work:

- Computer software that detects what programs are being run and what websites are currently open
- A Bluetooth module that will receive signals from the user's computer
- A sound-emitting device (i.e. a piezo buzzer)
- A small microcontroller that handles the signals from the Bluetooth module
- Power circuit for handling the different voltages and charging

Visual Aid

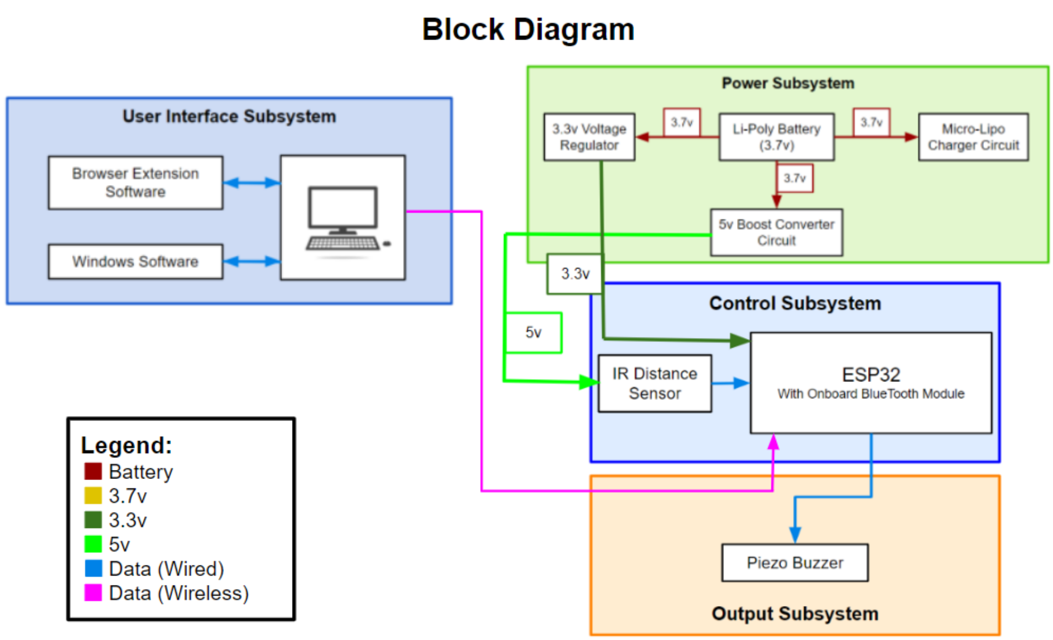


High-Level Requirements

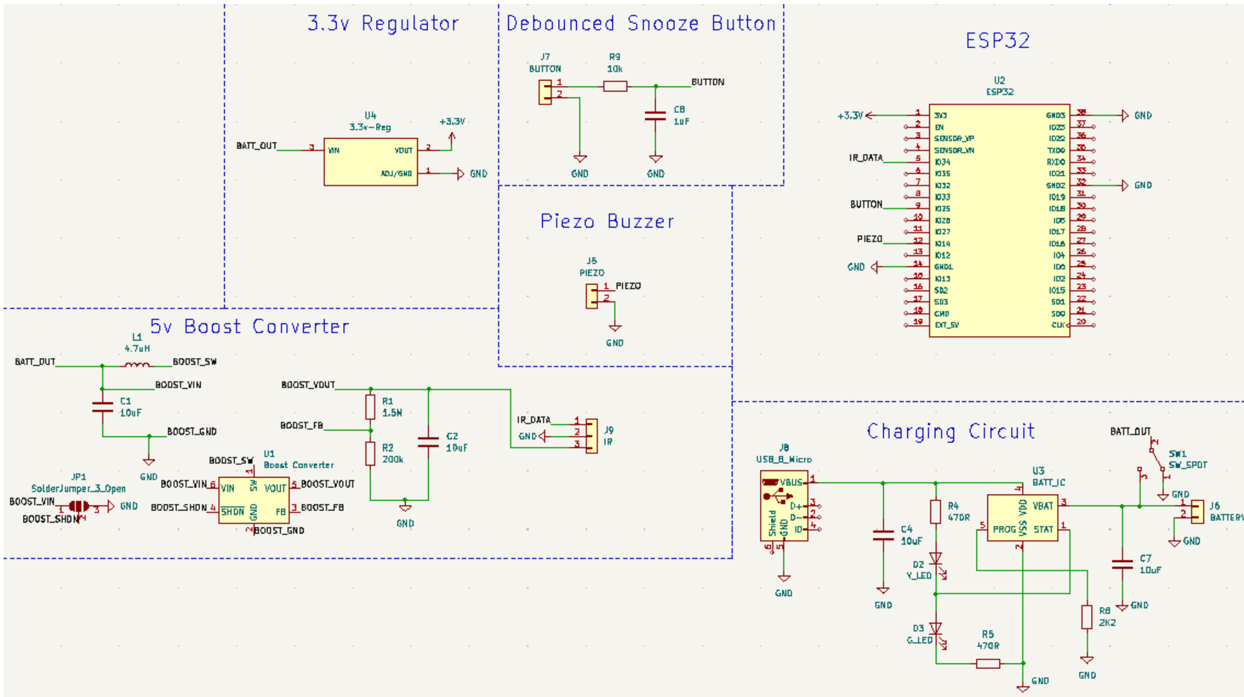
- The watch must be able to wirelessly connect to the computer via Bluetooth.
- The watch's output must be noticeable/annoying to the user for the watch to be effective at deterring procrastination (between 40-60 dB).
- The delay between opening/closing a blacklisted website and the watch buzzer turning on/off should be small (less than 6 seconds).

Design

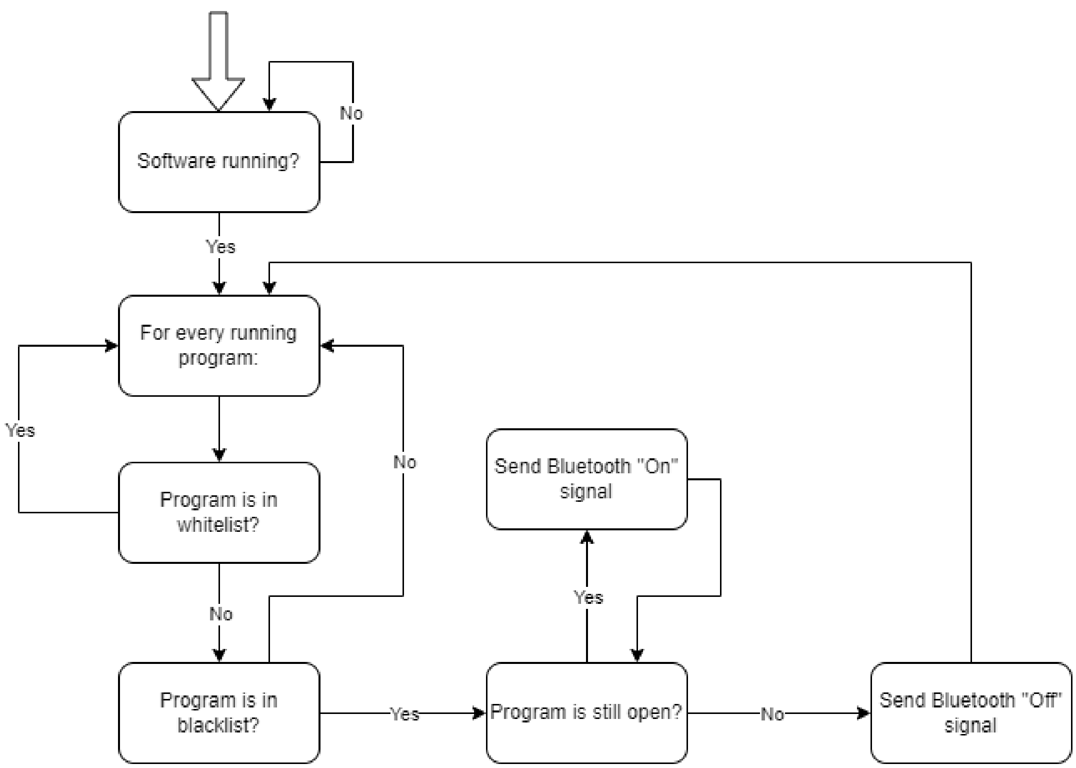
Block Diagram



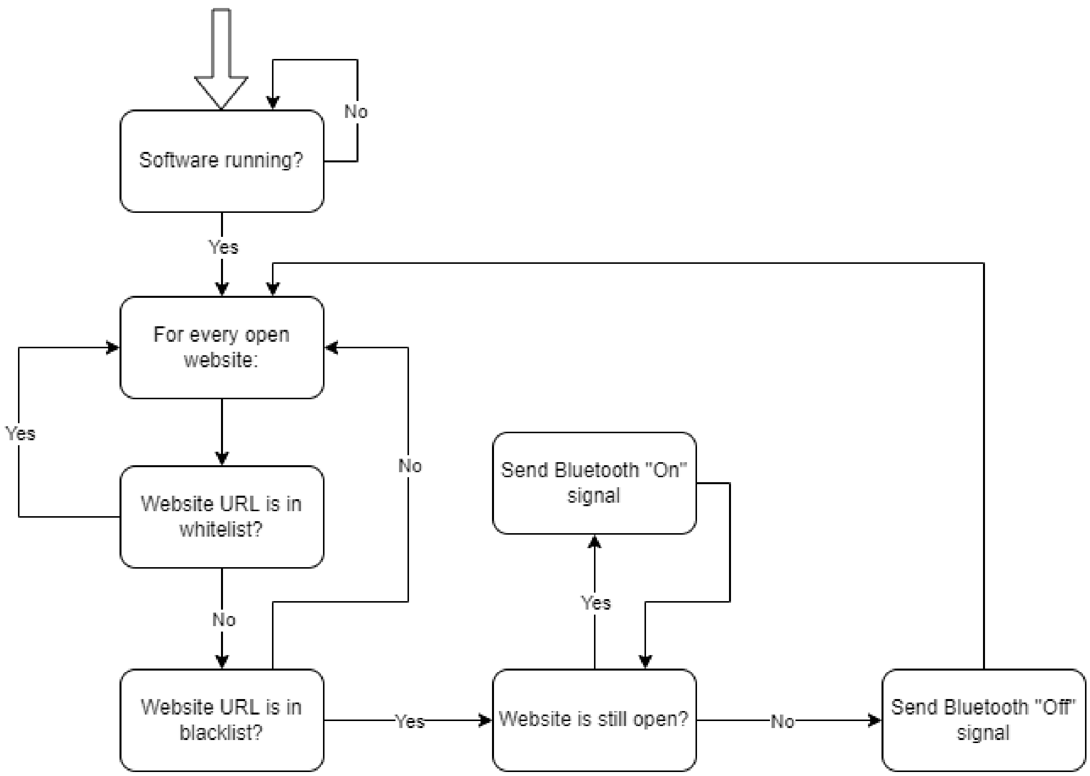
Circuit Schematic



Windows Software Flowchart



Browser Extension Software Flowchart



Subsystem Overview

Power Subsystem

The Power Subsystem provides all of the power for all of the components in our device. Using the 3.7v battery, 5v boost converter and the 3.3v voltage regulator, the Power Subsystem is able to provide all of the necessary voltages that the various components in our device use. The Power Subsystem connects to the Control Subsystem by providing 3.3v to the ESP32. It also connects to the Control Subsystem by providing 5v to the IR sensor.

Control Subsystem

The Control Subsystem receives any Bluetooth data coming from the host computer so it knows what to tell the microcontroller (e.g. to turn the piezo buzzer on/off). The Bluetooth module in the Control Subsystem gets the Bluetooth data, and then relays it to the board microcontroller. The Control Subsystem connects to the Output Subsystem by the board microcontroller generating a 1000 Hz square wave, which is sent to the piezo buzzer in the Output Subsystem. It will send this wave while the website/program stays open until 3 minutes have passed, where it will stop and wait for another 3 minutes before sending the signal again for another 3 minutes if the website/program continues to stay open. There will also be an IR sensor that connects with the ESP32 microcontroller and it will detect a user at the desk and if the user is absent for a certain amount of time the ESP32 will send the square wave to the buzzer.

Output Subsystem

The Output Subsystem receives waves from the board microcontroller and plays it out loud via the piezo buzzer in the Output Subsystem. The Output Subsystem's main function is to annoy the user (via the loud piezo buzzer) whenever a blacklisted website/program is opened, and it keeps playing until the blacklisted websites/programs are closed. The effectiveness of our project depends on the Output Subsystem.

User Interface Subsystem

The User Interface Subsystem reads programs and websites running on the user's host computer. The user can whitelist/blacklist websites/programs via Windows software and browser extension software. The detection of blacklisted websites/programs and the user interface to add websites/programs to the blacklist/whitelist is provided by the software in the User Interface Subsystem. When the software detects a blacklisted website/program running, it sends a wireless signal via Bluetooth to our device's Bluetooth module, which is how the User Interface Subsystem connects with the Control Subsystem.

Subsystem Requirements

Power Subsystem

Requirements	Verification
The Power Subsystem must be able to supply 3.7V from the battery once it has been charged.	Use an oscilloscope to determine voltage across battery
The Power Subsystem must be able to supply at least 3.3V to power ESP-32.	1A. Connect battery to 3.3 voltage regulator input. 1B. Connect 3.3V regulator output to ESP-32 input. 2A. Use an oscilloscope to determine voltage between regulator and ESP-32. If the red light comes on on the ESP-32 it is receiving power.
The Power Subsystem must be able to supply at minimum 4V and at maximum 7V to	1A. Connect battery to 5V boost converter input.

power the IR Sensor. Ideally should be around 5V.	1B. Connect boost converter output to IR Sensor input. 2A. Use an oscilloscope to determine voltage between boost converter and IR Sensor.
The Power Subsystem must be able to supply power to the device for at least 6 hours on a full charge	1A. Charge the device battery fully using microUSB. 1B. Connect device to host computer and use normally, visiting at least one blacklisted site an hour. 1C. Determine what time the battery stops being sufficient to power the system by monitoring when the device does not continue working.

Control Subsystem

Requirements	**Verification**
The Control Subsystem must be able to receive a bluetooth signal sent from a host computer to the bluetooth module	Connect bluetooth module to correct power and connect with computer. Send training data through bluetooth and verify at the bluetooth module data pin that data was received using a microcontroller program to display output.
ESP32 must be able to interpret the signal received by the Bluetooth module to turn on/off output	Connect bluetooth module to correct power and connect with computer. Write microcontroller code that uses data sent by the host computer through bluetooth to turn on and off an LED.
ESP32 must be able to control how long it sends a square wave to the buzzer such that it turns on and off in 3 minute intervals	After coding the behavior, open a banned application. As soon as the buzzer starts buzzing, time the duration of the sound. After it stops, time the duration up until it starts buzzing again. Compare the times to see if they are within ± 5 seconds of 3 minutes.
IR sensors must be able to give distinct voltages for something being about 6 inches from it and for nothing being in front of it for at least 2 feet.	After the IR sensor has adequate power,read the voltage at the output pin and verify that it is distinct for the IR sensor with a person standing 6 inches from it and nothing being in front of it.

Output Subsystem

Requirements	Verification
ESP32 must be able to send a 1000 Hz square wave to the buzzer	Load code to produce the wave on the ESP32 and run it while using an oscilloscope to verify that the wave is of the correct form and within ±50Hz.
The piezo buzzer must be able to output a noise of about 40dB-60dB whenever the board microcontroller sends a 1000 Hz square wave to the piezo buzzer	Once the square wave has been verified, wire that wave into the input of the buzzer and measure the sound using a decibel sensor.

User Interface Subsystem

Requirements	Verification
The User Interface Subsystem must be able to allow a user to add/remove applications/websites to a blacklist/whitelist managed by the browser extension software and Windows software	1A. Use the interface to add and remove websites from the blacklist/whitelist. 1B. Visit those sites and check if the device is performing the appropriate action.
The User Interface must be able to detect what applications and websites are running/open	1A. Give a list of applications and websites to the program to check. 1B. Make sure that some are open and the others are closed. 1C Read the program's output and verify that it is correct about which programs are open and closed.
The User Interface must be able to send a 'start'/'stop' signal via Bluetooth to the ESP32	1A. Code the ESP32 to be able to interpret data from the host computer. 1B. Send signals from the host computer to the device over bluetooth and verify that the ESP32 can discern between the two signals 'start' and 'stop' (which can be any arbitrary signal such as 0 or 1).

Tolerance Analysis

The battery power is one area of tolerance that is important for our design because if the battery life is not sufficient, users will not be satisfied. On the other hand if the battery we use is too large then it will cause the device to be heavier than necessary which hinders the user. To get the total lifetime of the battery under the designs current parts we need to determine I_{total} which is the total current draw on the battery as well as its voltage V_{cc} and C the total mWh of the battery. Then we can use the equation, Battery Life = (I_{total} * V_{cc})/C. We also use a linear voltage regulator between the battery and the bluetooth module which has an input voltage of 3.7V and an output of 3.3V. This ratio 3.3 / 3.7 gives us the efficiency of the regulator and will determine the power supplied by the battery of the bluetooth module.

As retrieved from data sheets and research, the bluetooth module will draw about 30mA of current in the worst case scenario and since it is behind the regulator its effective power drawn from the battery would be (3.3 * 30) * (3.3 / 3.7) = 88.3 mW. The microcontroller and buzzer will draw 8mA and as much as 10mA respectively, so their effective powers will be (8 * 3.3) = 26.4mW and (10 * 3.3) = 33mW. The total power drawn from the battery by these components will be 147.7mW and given that the battery is rated at 1295mWh at full charge, our device should be able to run for 1295mWh / 147.7mW = ~8.75 hours. This is a good amount of time that will allow the user to use it for just about as long as work day without having to charge.

Cost and Schedule

Parts

Part	Manufacturer	Units Required	Retail Cost ($) (per unit)	Bulk Purchase Cost ($) (per unit in orders of 1,000 units)	Actual Cost ($)
LD1117V33 IC REG LINEAR 3.3V 800MA TO220AB [15]	STMicroelectronics	1	0.84	0.37030	0.37030
1051330001 CONN RCPT USB2.0 MICRO B SMD [1]	Molex	1	1.17	0.70762	0.70762
XZM2CYK54WA-8 LED YELLOW CLEAR CHIP SMD [21]	SunLED	1	0.57	0.19180	0.19180
XZDGK54W-8 LED GREEN CLEAR CHIP SMD [20]	SunLED	1	0.67	0.18508	0.18508

MCP73831T-2ACI/OT IC BATT CNTL LI-ION 1CEL SOT23-5 [17]	Microchip Technology	1	0.76	0.69	0.69
UM3429S STEP UP DC DC CONVERTER [18]	Union Semiconductor (HK) Limited	1	0.4175	0.38	0.38
258 BATTERY LITHIUM 3.7V 1.2AH [3]	Adafruit Industries LLC	1	9.95	9.95	9.95
GP2Y0A21YK0F SENSOR OPTICAL 10-80CM ANALOG [13]	SHARP/Socle Technology	1	13.50	6.63307	6.63307
1739 BUZZER PIEZO 12V 30MM FLANGE [2]	Adafruit Industries LLC	1	0.95	0.95	0.95
ANT11SEBQE SWITCH TOGGLE SPDT SOLDER SEAL [5]	CIT Relay and Switch	1	1.69	1.12167	1.12167
ERJ-HP6F4700V RES 470 OHM 1% 1/2W 0805 [8]	Panasonic Electronic Components	2	0.40	0.05558	0.11116
ERJ-HP6J222V RES 2.2K OHM 5% 1/2W 0805 [10]	Panasonic Electronic Components	1	0.27	0.03690	0.03690
ERJ-P06J204V RES SMD 200K OHM 5% 1/2W 0805 [11]	Panasonic Electronic Components	1	0.13	0.01980	0.01980
ERJ-6ENF1504V RES SMD 1.5M OHM 1% 1/8W 0805 [9]	Panasonic Electronic Components	1	0.10	0.01512	0.01512
LQM21PN4R7MGHL FIXED IND 4.7UH 1.2A 275MOHM SMD	Murata Electronics	1	0.29	0.11684	0.11684

[16]					
C2012X7R1A106K125AE CAP CER 10UF 10V X7R 0805 [6]	TDK Corporation	4	0.44	0.11495	0.4598
ESP32-DEVKITC-32U EVAL BOARD FOR ESP-WROOM-32 [12]	Espressif Systems	1	10.00	10.00	10.00
Total Cost:					**31.93916**

Labor

We are basing our analysis on the formula: ($/hour) x 2.5 x (hours to complete). Using a conservative estimate of $25 per hour and about 80 hours to complete, each team member would cost $5,000. And since we have a total of 3 team members, the total cost for labor is $15,000.

Grand Total

Total cost including parts and labor per 1,000 units is $46,939.16.

Schedule

Week 1

- Finish design document
- Complete rough draft of PCB design and parts layout
- Start high-level software design

Week 2

- Start and finish rough draft of PCB design in CAD
- Order all parts
- Start creating software for Windows and Chrome extension

Week 3

- Finalize PCB CAD design and order PCB
- Continue working on software functionality for Windows and Chrome extension software

- Start breadboard prototyping the device

Week 4

- Continue working on software functionality for Windows and Chrome extension software
- Test basic functionality of all parts
- Solder parts to PCB

Week 5

- Finish software functionality for Windows and Chrome extension software
- Test Bluetooth functionality and pairing with host device

Week 6

- Start designing and creating software GUI
- Test Bluetooth signal reception from device and microcontroller response

Week 7

- Finish software GUI
- Begin testing device functionality

Week 8

- Finish testing device functionality
- Finalize software and the device

Ethics and Safety

In the interest of following principle 1.2 of the ACM Code of Ethics, we will ensure that the possibility of being injured or harmed by our project is minimal by selecting a piezo buzzer with a low decibel range that match our requirements of being 40-60 dB as to not harm the ears of our users [3]. We hope to respect privacy and honor confidentiality of our users as stated in principles 1.6 and 1.7 by having users input the desired websites and programs to blacklist rather than automatically collecting data on the users browsing habits and having the device decide [1]. We will act in accordance with principle 2.9 by thoroughly testing and updating the functions of our device to make sure it works as intended, focusing on specifically making sure that the device is able to detect user-inputted websites and programs, and emitting a safe level of noise when doing so. In the same vein, we will ensure that this data remains secure so that there are no potential leaks of information of any kind. In order to follow the guidelines of the IEEE Code of Ethics, we will keep the safety, health, and welfare of the public as a top priority when designing our project [2]. Our project involves a lot of potentially dangerous electrical components. Should any of these components prove to endanger a user in any way, we will make revisions to our design in order to remove the threat. However, since we are dealing with very low voltages (5v), our project is not as dangerous as other projects dealing with higher voltages. But since we are dealing with lithium-ion batteries, we will link a University lab safety document to mitigate any possible issues with batteries[4].

References

[1] "ACM Code of Ethics Booklet - Association for Computing ..." [Online]. Available: https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-booklet.pdf. [Accessed: 22-Feb-2022].

[2] "IEEE code of Ethics," IEEE. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 22-Feb-2022].

[3] "What noises cause hearing loss?," Centers for Disease Control and Prevention, 07-Oct-2019. [Online]. Available: https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html#:~:text=Common%20Sources%20of%20Noise%20and%20Decibel%20Levels&text=A%20whisper%20is%20about%2030,immediate%20harm%20to%20your%20ears. [Accessed: 22-Feb-2022].

[4] "Battery Safety." Illinois [Online]. Available: https://drs.illinois.edu/Page/SafetyLibrary/BatterySafety. [Accessed: 22-Feb-2022].