Continuously Recording Microphone

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ECE 445, February 6, 2019

Introduction

Objective

In the modern day, people all have smartphones that can record audio whenever they want. However, this is only for pre-planned moments when people know they want to record. Sometimes there are points in time you'd wish you were recording but missed the chance because you weren't ready or didn't expect to. It's moment like these that are unplanned, spontaneous or unexpected that our device wants to capture.

Our device's purpose is to allow easy recording of audio without needing to click 'start'. That is, the device will be constantly recording without saving the audio files until told to do so. In addition, the device will have a second feature that allows automatic saving when the user is in danger or in a quarrel for safety purposes. Both features will record clips that would never be recorded otherwise.

Background

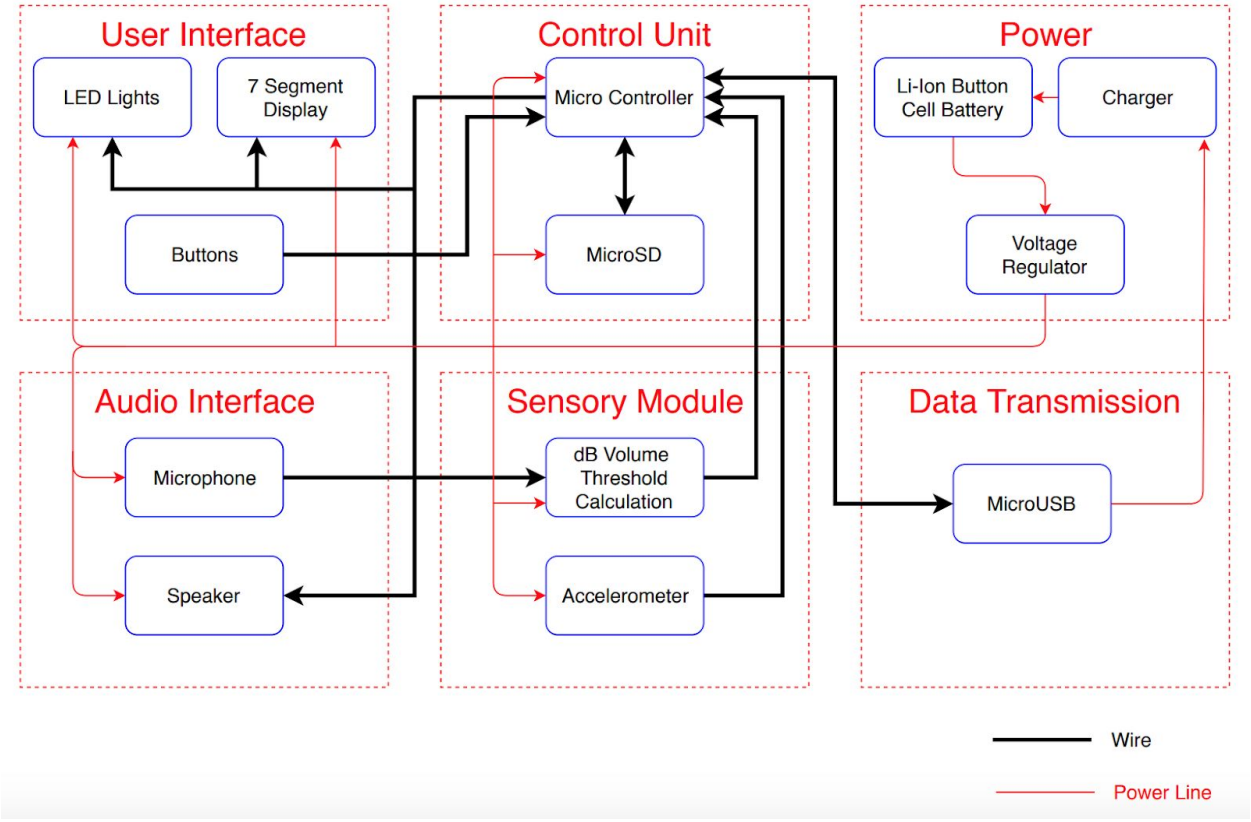
Currently, there are devices out there that have similar functions, such as 'Kapture' [1]. It has the same basic concept of recording audio before saving. It uses a tapping feature to save and upload audio files to a cloud then transfers it to the iphone or android for clipping and sending. Instead of using the accelerometer to determine when to save on command, we are using the accelerometer to determine when to save automatically. For on command saving, we decide to use buttons that similarly, will light up and show physical movements to signal the user has saved a recording. We are also implementing cropping directly on the device with buttons and a playback system to replay the cropped audio. In general, our device is suited for safety when the user cannot click save in dangerous situations.

High Level Requirements

- Device must be able to store at least 16 hours worth of audio and be running a full day without charging
- Device must be able to detect when user is shoved and detect when a noise reaches a certain volume
- Device must be small enough to fit on a wristband

Design

Block Diagram



User Interface

- The user interface allows the user to see the status of the device as well as interact with it. There will be a status LED in order for the user to see when the battery is low. The seven segment display is used in order for the user to see which clip they have selected and the buttons are used to save a clip, turn the device on/off, and begin/end cropping.
- We have been considering two methods to accomplish clip cropping. One would be to use a couple knobs on the device to change the length of the clip. Another would be to implement a gesture that would allow users to crop a clip by rotating their wrist. Our TA suggested that the best way to accomplish the gesture system would be to implement a machine learning solution. However, this might prove to be infeasible for our project, so further testing will have to be done.

LED Lights

- We would have a red and green LED to indicate battery life. The green LED will be on when the battery is more than 75% full and the red LED will be on when

the batter is less than 75% full. This will be done by communicating with the microcontroller

- *Requirement: Able to last at least for 5 years while still being functional*

7 Segment Display

- We would have a 4 panel 7 segment display in order to show the user which clip they are currently selecting/recording to. The display would communicate with the microcontroller to display the correct numbers.
- *Requirement: The display must be thin enough such that it does not make the wristband too bulky. Preferably less than 0.5cm.*

Buttons

- We would need three buttons in order for the device to work. One would be to turn the device on and off, one would be used to save a clip, and one would be used to start and stop cropping a clip. We would be able to cut down on one button by having the on/off button be used to start and stop cropping as well. Pressing the button for a short period of time would start/stop cropping while holding the button would turn off the device.
- *Requirement: Small enough to fit seamlessly with the wristband*

Control Unit

- The control unit consists of the microcontroller and a microSD card for storage. The microcontroller's job is to take all of the audio data coming from the microphone and tell it where to go. It would also control when to start saving audio automatically when something happens to the user.

Microcontroller

- The microcontroller would take in data from the accelerometer, our volume calculations, the buttons, as well as the micro USB. The data from the accelerometer and the volume would tell the microcontroller when to automatically save audio and the buttons would be used to manually save audio.
- *Requirement: Able to process audio with a sample rate of 44.1kHz and bit depth of 16 bits. This turns out to be 705.6 kbps per channel.*

MicroSD

- The microSD would save data coming from the microcontroller and be able to output data when the device is connected to a computer through the microUSB port. The SD card would communicate with the microcontroller using SPI protocol.
- *Requirement: The SD card would have to be at least 8 gigabytes large*

Power

- An electric battery is required to power the whole system to last at least half a day. The constraints of the battery includes being small enough to fit in a wristband and not overheat and cause the user to feel high temperatures from the wristband.

  Charger
  - The charger needs to be able to charge the li-ion button cell batteries through a charging IC with power coming from a micro USB. The chip needs to be able to charge fully the batteries within 6~9 hours.
  - *Requirements: Able to correctly charge the battery at a safe speed without causing overcharge*

  Li-Ion Button Cell Battery
  - The button cell battery is the battery of choice due to its small size. It should be able to have the device last at least 8 to 9 hours.
  - *Requirements: Able to supply at least 3.3V. Needs to be running at a temperature that isn't too hot for the user.*

  Voltage Regulator
  - Since most Li-Ion batteries supply more than 3.3V, the voltage regulator would be able to step down this voltage to supply the correct amount for the chip using it.

Audio Interface

- The audio interface includes at least one microphone and one speaker. The microphone needs to be constanting recording and sending data to the dB threshold calculation circuit. The microcontroller sends audio data to the speaker for playback or alert sounds.

  Microphone
  - A simple electronic microphone that can record the frequency range of what a human can hear. Audio data is sent to a circuit to calculate the dB of the audio and to the microcontroller to determine what to do with the audio.
  - *Requirement: Able to record sound from 20Hz to 20kHz.*

  Speaker
  - Audio data is sent from the microcontroller to the speaker must be played out from the device.
  - *Requirement: A small speaker that can play audio that human sounds can be recognize with clarity.*

Data Transmission

- Data transmission is all done with the micro USB. The micro USB is connected to both the microcontroller and the charger. On the microcontroller side, the USB takes in data

from the microSD to be saved onto a computer. It acts as the power source for the charger IC.

Micro USB

- A micro USB that can be plugged into a computer to download audio files from the device to the computer.
- *Requirement: Capable of charging the device and manipulating stored files in the MicroSD via the microcontroller.*

Sensory Module

- The module is the main module for determining whether it is an appropriate situation to automatically save recorded audio files. The first method to determine the situation is by calculating the decibels of the recorded audio and see if it is near the range of people shouting or fighting or life threatening accidents. The second method is to use an accelerometer to determine any type of falling or fighting movement happening to the user.

dB-Volume Threshold Calculator Circuit

- A circuit that will take in audio data from the microphone to calculate the dB of the audio data. It will send both the audio data and dB value to the microcontroller where it will determine if automatic saving should begin.
  Requirement: Capable of processing audio signals at a frequency of 44.1kHz.

Accelerometer

- Similar to the threshold circuit, the accelerometer will have fixed values that will be predetermined and programmed onto the microcontroller to determine if the user falls down or is in a fight with someone. The data from the accelerometer will be sent to the microcontroller.
  Requirement: Needs to be able to distinguish between random movement and actual dangerous situations.

Risk Analysis

- Due to our backgrounds, we believe that power will be the hardest block for us to implement. Care and attention to detail will be taken to ensure that this block does not cause problems for our overall project. One that we will have to solve is monitoring the voltage that the battery outputs. During use, it is imperative that the battery not drop lower than its recommended lowest voltage to prevent damaging the battery. It is also important to monitor the voltage while charging such that the battery does not overcharge and become damaged. Since we are working with a Li-ion cell battery, extra care must be taken such that the battery does not explode or cause hard to the user in any way.

Ethics

- Following the code of ethics put out by the IEEE and the ACM [2], [3], our device may violate the code in terms of privacy. Because our device would make it easy to record private conversations with the click of a button, there may be a violation in regards to section 1.2, 1.6, and 1.7 of the ACM code of ethics. To combat this, we will take additional measures into ensuring that all parties are informed of when the device has saved a clip of audio. Furthermore, the device is intended to be used in public, where the expectation of privacy cannot be ensured.
- A second point of violation comes from point 6 of the IEEE code of ethics and section 2.6 of the ACM code of ethics. As stated above in the Risk Analysis section, we have a minimal background in power management. Therefore, we have an obligation to the code to research all of the necessary information to prevent the device from failing and potentially harming someone.

Safety

- The main concern of safety for our device would be from the use of a Li-ion cell battery. Our team has read and understand the potential hazards listed out in the battery safety document found on the ECE 445 document and intend to follow the procedure thoroughly. We believe that the use of a small rechargeable battery is necessary for our project to be successful since it must be able to operate independently of an external power source and small enough to fit in a wristband.

References

[1] M. Sarow, “Kapture: the audio-recording wristband,” Mar. 2014. [Online] Available: https://www.kickstarter.com/projects/1483824574/kapture-the-audio-recording-wristband [Accessed: Feb. 7, 2019]

[2] “IEEE Code of Ethics,” *IEEE* [Online] Available: https://www.ieee.org/about/corporate/governance/p7-8.html [Accessed: Feb 7, 2019]

[3] “ACM Code of Ethics and Professional Conduct,” *ACM* [Online] Available: https://www.acm.org/code-of-ethics [Accessed: Feb 7, 2019]