BEAT STARTER

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1 Introduction

1.1 Objective

One issue in today's society is about how communities throughout America have a wide range of opportunities that they offer. For example, one environment could have thousands of available resources and opportunities whereas another area might only have a handful of those resources. In order to help bridge this gap in opportunity, the Hip Hop Xpress is a bus that will travel to different communities throughout the US to educate people on both music and technology to show people the resources that are available to them [2]. We want people, of all ages, to come together and become a part of the bus and their community in an educational way. By adding an easy-to-understand, interactive device that anyone could pick up and use would drastically help reach this goal by having them interact with some of the resources their environment does not currently offer. In order to meet this objective, we will design our own flat board, similar to a drum board, that would sit on top of a table. The board would have a wide variety of different sounds to select and combine in a loop to create personal beats. It would be portable in order to be set up outside the bus, so people can use our board without having to get on the bus. The board's instruments would be organized into several, color-coded sections.

1.2 Background

For many adolescents growing up in today's society, they are immensely impacted by their surrounding environment. For instance, some individuals have a lot fewer opportunities than others purely due to their surroundings. However, for many kids in America, their certain circumstances do not exhibit all the possible resources that exist around the world. If we are able to show kids something that they find very cool or interesting, we have a chance at changing those individuals' futures, quite possibly for the better. One method that is able to be reached and understood by many young people is music [2]. With the help of the Hip Hop Xpress, our idea is to present some of the simple yet interesting aspects of music and technology to kids that have never seen or even knew of devices like these existing. Overall, we want to help spark interest in the musical and technological industries in hopes that one day, someone finds their true passion from some of the resources that were not previously offered to them from their environment.

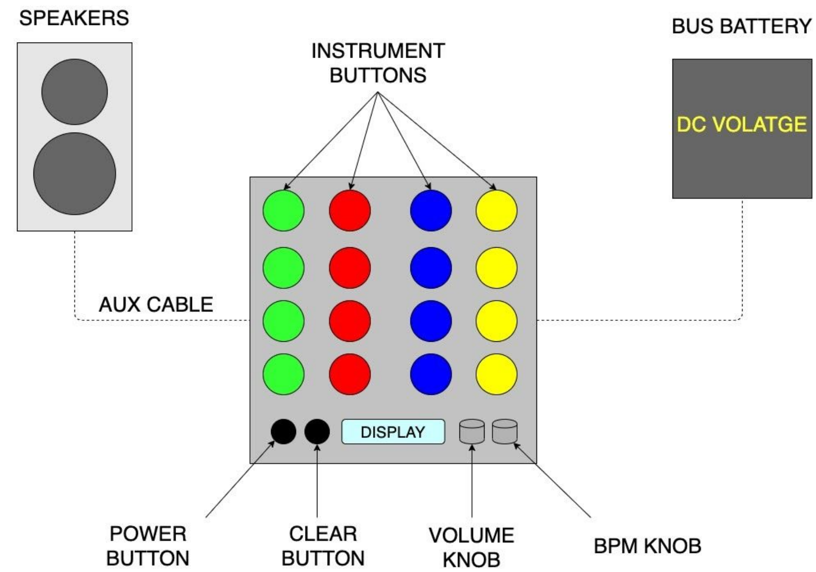

Figure 1. Physical Design

1.3 High-level requirements list

- We want at least two people to be able to use our device at the same time.
- Our device has at least four instrumental sounds, with 3 different pitches each.
- Our device will have a range of 60-110 beats per minute (BPM).

2 Design

Our device will be powered by the bus's battery which is DC power. A three-prong outlet cord will be connected to a voltage regulator to drop the voltage in order for the PCB to function. Our design will consist of a flat board, similar to a drum board, that would sit on top of a table. The board would have a wide variety of different sounds to select and combine in a loop to create personal beats. The board's face will have various buttons and switches to receive user input. We will have buttons to control the instruments, power, and clear function and turn knobs to adjust volume and BPM. The created beats that are running in a loop will be stored and accessed in memory. For the display, the device will have a simple display panel to indicate the current settings. This includes volume level and beats per minute (BPM) count. The LCD panel will display the content provided by the PCB.

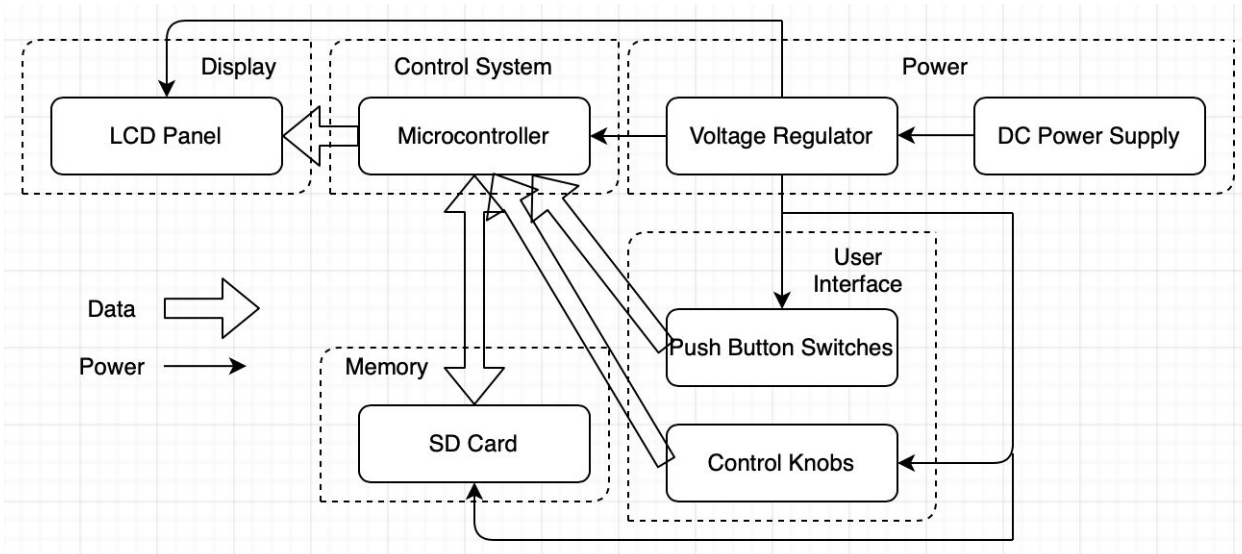

Figure 2. Block Diagram

2.1 Power
The power supply is needed to ensure all components of the device remain functional. Power from the bus battery must be regulated down to 3.3V to apply to our system [5].

2.1.1 DC Power Supply
We plan on using the bus's battery to supply power to our device.

Requirement: If we are not able to use the bus's battery to power our device, then we'll need to supply our own. This will need to be at least a 4V 500mAh battery.

2.1.2 Voltage Regulator
The bus battery supplies power at a much higher voltage than we need. Due to this, we need to be able to step down the voltage to a level our system can handle.

Requirement: Must provide 3.3V +/- 5% from a 12-15V source.

2.2 Control System
The control system needs to take in information from the buttons, knobs, and SD card to write to memory, display the proper readings, and output the created audio signals.

2.2.1 Microcontroller
The microcontroller needs to be able to detect the correct button, corresponding to an exact instrument and pitch, that was pressed by the user from the signal that came from the respective push button switch. Then, it needs to read memory on the SD card to send that audio signal to output while at the same time write memory to keep repeating that sound in the loop. If the BPM or volume knobs are turned, it needs to adjust the rate of the beats and the volume level on the speaker itself accordingly. It also needs to be able to output these new changes to BPM or

volume on the display. When the user hits the clear button, it needs to be able to write memory to erase all of the previously created beats.

Requirement: Must sink 3.3V +/- 5%.

2.3 User Interface

The board's instruments would be organized into several, color-coded sections. Each instrument based section would contain several different buttons. We would also include BPM and volume knobs that would also be sending data to the PCB.

2.3.1 Push Button Switches

Instrumental Buttons: large, color-coded buttons organized by instrument and pitch.
Power Button: allows the user to turn the device on and off.
Clear Button: removes existing sounds from the loop to start a new session.

Requirement: Every button must have a maximum response time of 0.1 seconds [4].

2.3.2 Control Knobs

BPM Knob: gives users the ability to adjust BPM of the loop playing.
Volume Knob: allows for volume adjustment.

Requirement: Every control knob must have a maximum response time of 0.1 seconds [4].

2.4 Memory

The memory needs to be able to be read and written.

2.4.1 SD Card

The SD card will contain our library of samples. It needs to be read when a button is pressed and written to keep that sound repeating in the loop. When the clear button is pressed, it clears the memory of the sounds in the loop.

Requirement: Needs to be at least 1 GB.

2.5 Display

A small panel located on the face of the board used to provide the user with information and status of settings.

2.5.1 LCD Panel

A small panel located on the face of the device to display settings such as BPM and volume.

Requirement 1: Panel must be visible in daylight.
Requirement 2: Panel must receive a maximum of 1 mA.

2.6 Risk Analysis:

The control system is a great risk to the success of our project. This is where software meets hardware. Every subsystem of our device connects to the PCB. Significant programming will have to go into our control system in order to meet our deliverables. We at least need code that can modify BPM of our audio signal in real time. The PCB will be connected to our memory system. Time discrepancy between memory access and looping will be something challenging we must overcome. Due to our device being able to support multiple users, our system will also have to recognize simultaneous button presses. The overall amount of input that can be done at once, along with correct timing of every button press, causes our biggest problem due to the amount of simultaneous data that must be processed.

We will have to find the most adequate quantization of button presses to stay on beat so that the learning curve of our product stays low, without taking away from the uniqueness and desired result given by the user. If the quantizing value is too high, then the user will notice a delay from their input to the produced sound. If the quantizing value is too low, a new user will struggle to make a beat that sounds desiring.

3 Ethics and Safety

It is important to us to not break any of the Ethic Codes set before us by IEEE. We plan on accomplishing this by taking diligence during the development of our project. According to Code 1 of the IEEE Code of Ethics, we will paramountly hold the safety and health of the public by making the device durable and easy to use [3]. We will ensure that the electronic wiring, the only hazardous part of our design, is wired correctly and not accessible by the user.

The purpose of our project is to be able to bring people of all ages in the community together through the creation of their own hip-hop music. Adhering to Code 5 of the IEEE Code of Ethics, we will “improve the understanding by individuals and society…” of music and the effect it has on communities, through our technology [3]. We will be able to tell if the understanding of the community and individual has improved, based on the ability to use our device.

Our device will use sampled noises and sounds from libraries constructed by other users and companies. We will ensure the correct citing and give credit based on the specific guidelines of the chosen resource. This adheres to Code 7 of the IEEE Code of Ethics [3].

Our device will be powered from a 12-15V source courtesy of the bus. This is too much voltage for our system to handle, so we will use a voltage regulator to allow for 3.3V to pass to our system. This will prevent the circuit from erupting and causing possible harm to any user. The design of our device is simple and easy to understand as to reduce the possibility of misuse and harm. The corners of our design could harm a user and the device if it was dropped so we could add rubber protectors on the sides to prevent this.

One potential hazard we have considered for our project is potentially blowing out the speakers connected to the device. The speaker receiver can usually handle at max +16dB, but keeping it below -6dB will almost always prevent the receiver from being over-driven [5]. Therefore, our volume knob will keep a range from -infinity(mute) to -6dB. The gain and drive of our sample will be universal so that there are no discrepancies between the volume of each sound.

References

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[2] The Hip Hop Xpress, publish.illinois.edu/hiphopxpress/.

[3] Ieee.org, "IEEE IEEE Code of Ethics", 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html.

[4] Project, Gnome. “Acceptable Response Time.” Acceptable Response Times, developer.gnome.org/hig-book/unstable/feedback-response-times.html.en.

[5] “Tips to Ensure Your PCB Power Distribution Requirements Are Satisfied.” Tempo, 19 June 2019, www.tempoautomation.com/blog/tips-to-ensure-your-pcb-power-distribution-requirements-are-satisfied/.