Project Plan: Cyren

Members:
Justin Shaver, Thomas Frye
Will Pigg, Chandler Davis,
Caleb Hendrickson, Dan Bohlke

Table of Contents

List of Figures

List of Tables

Acknowledgement

Our client, Dr. Randall Geigar, has made this project very open ended. All of the design features, use cases, functional requirements will be up to our team to decide. The only requirement is that the target audience must be musicians and this project must utilize our skills as engineers and that we learn and grow from this experience. Our adviser, Dr. Chen Degang, has offered his support with the technical aspect of this project, specifically electronics, in the form of advice or answering questions. Dr. Geigar has also offered his assistance with any advice we may need.

Problem Statement

Musicians often require many devices in order to achieve desired sounds. In the case of a guitarist, a combination of several pedals may be required to produce a specific level of distortion to emulate a bassline. Another combination of pedals would be needed for the lead or chorus. When working with a multitude of devices, the musician will have to make sure that there are no compatibility issues and spend a great deal of time adjusting the device settings to find combinations that sound well together. Many music devices do not have features to save or load settings, which requires the musician to manually adjust their equipment each time they switch between sounds or effects. The musician is also required to store their equipment which may pose a problem under tight constraints. In the case of live performances, especially those that will require travel, having the space required in a vehicle may be quite the challenge along with ensuring that the equipment remains safe and undamaged. Also, working with many devices while on stage may require frequent breaks between songs to switch between equipment or adjust settings. When performing in a band, each musician will often have their own equipment for their instrument which even further emphasizes the problem with requiring breaks during performances along with storage and transportation. The need to have several devices for music production presets problems with storing and transporting the equipment, ensuring compatibility between devices, and seamless live performances.

Operating Environment

The end product will be designed to appeal specifically to musicians and to function properly in any environment in which they wish to produce music. This will include casual use at home, in an open space for jam session with band mates, or on stage during a live performance. For the design to maintain functionality in these conditions, the product must be durable. The device will often be used on the floor where it could potentially collect dust and frequent scuffs and scratches. It will be important the device chassis is stable and made of a robust material. This will also be important for interacting with the device as it will have several stomp buttons and pedals. The product will also be expected to withstand frequent travel, especially for users that will be using the device for live performances or on tour. In addition, it is vital that the device can interface with existing music equipment, whether that be instruments, speakers, MIDI controllers, etc. This will require the use of pre-existing standardized connections for the I/O.

Intended Users and Intended Uses

As stated before, the target audience for this product is musicians. To appeal to the widest range of musicians possible, the design will be compatible with any instrument that can interface electronically. The device will be able to interface with multiple instruments at the same time, appealing to bands or even the one man band type. The end product could be used in an educational settings as well, possibly by teacher for demonstration purposes.

The design is intended to be used by a musician, alone or in a group, to interface with one or more instruments and produce music with a large and diverse selection of effects and layering options that are easy and user friendly to implement or modify while keeping all the sound processing on one device. The design will feature the ability to save and load effect combinations and layers allowing for seamless transitions between desired sounds and recording those sounds.

Use Case Diagram

Below is a visual representation of the intended uses of our design in the form of a use case diagram.

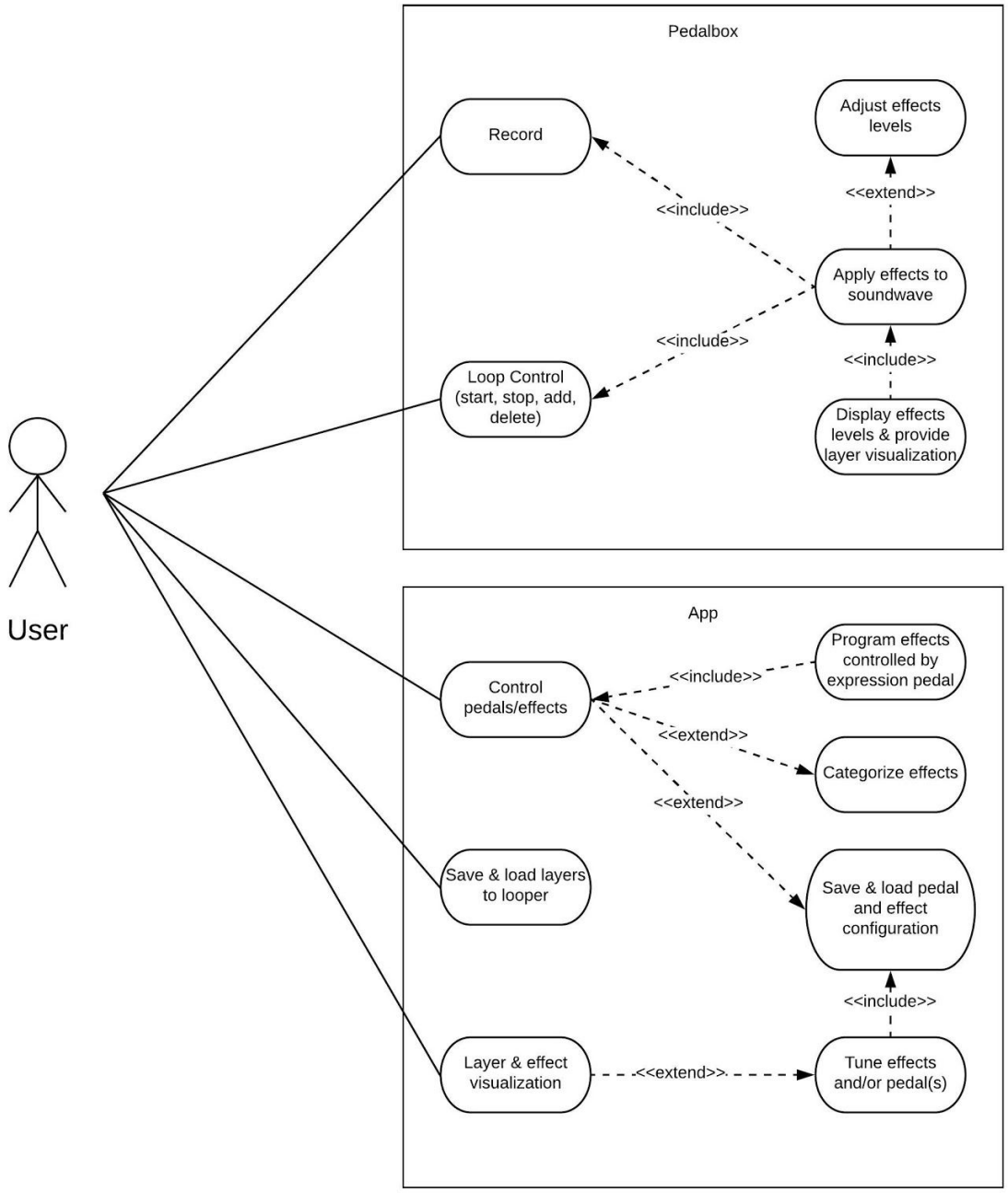

Figure 1: Use Case Diagram

Assumptions and Limitations

Assumptions

- The maximum of simultaneous users will be the amount of people playing instruments that are currently interfacing with the device along with, optionally, a person controller the device via the phone/desktop application.
- The primary user will be the person that has the device at their feet, will likely be a guitarist or pianist, but could be any other type of musician.
- While the musician is using the device with a instrument, it is intended that the user will interact primarily with the device itself rather than the phone/desktop application.
- The phone/desktop application will be used primarily to load preset effects or layers to the device before the musician intends to perform or play music.

Limitations

- Device must be able to be powered from a standard wall outlet.
- Device must be compatible with standard audio connections.
- Device controller must have adequate hardware resources to handle raw audio processing with minimal latency.
- Device chassis must be durable to withstand stomping for pedal and button functionality as well as wear and tear from travel.
- Device must have bluetooth connectivity to interface with phone application and USB connectivity to interface with desktop.

Project Deliverables and Specifications

Given the results of our meeting with our client, we discovered they would prefer to have a hands-off style approach. Our initial meeting showed us that they had many ideas, many of them not being completely related. By using some of their ideas and combining them with our own, we were able to construct our required project deliverables along with some itemized goals.

Required Project Deliverables

The final project (sound effect device) must:

- Be able to create, edit, and stack live/old recorded segments to be “looped”
- Allow the user to create, edit, and stack sound effects on real-time inputs and recorded loop segments
- Allow for the following inputs: XLR, L/R ¼ inch, 3.5mm auxiliary, MIDI, tuner knobs, stomp buttons/pedals, and expression pedal
- Allow for the following outputs: ¼ inch headphone, L/R ¼ inch, MIDI

Itemized Goals

We will strive to ensure the final project (sound effect device) will:

- Be able to store sound effect “profiles”, share sound effect profiles, and load sound effect profiles
- Provide a supplemental phone application to help improve the user interface experience
- Be durable enough for heavy use and provide a quality feel to the device
- Have a intuitive user interface while maximizing the potential of the device

Previous Work / Literature Review

Basic Terms

Guitar Pedals

- Effect pedals usually take the form of small metal boxes which sit on the floor in front of you. These can be switched on and off using your feet. Hence, pedals. The technology contained within these pedals is designed to alter your tone in any number of ways. One of the primary types of pedals around today are effects pedals.
- Common Guitar Pedal effects would include:
    - Delay/looping: Delay is a commonly-used effect where the pedal repeats your sound at predetermined intervals after you've played it.
    - Reverb: Reverb simulates the sound of your instrument being played in a larger physical space.
    - Drive: Overdrive is an effect that 'pushes' the guitar's signal before it reaches the amplifier.
    - Modulation: There are a few main types of modulation; chorus, phase, tremolo, wah and flange. These effects are very distinct and should be used with purpose/precision.
    - Tremolo: Making your signal subtly cut in and out of volume.

Live-Looping

- Live looping is the recording and playback of a piece of music in real-time using either dedicated hardware devices, called loopers or phrase samplers, or software running on a computer with an audio interface.
- Loopers allow you to record entire passages of play, then 'loop' them back (repeat them) whilst you play something new over the top. Lay down a basic chord progression, then solo of the top of it.
- This offers the ability for a single musician to create multiple layers to their live music, resulting in a sound close to that of a "full band".

Effect Stacking (Chaining)

- Guitar Pedal "Chaining" is the technique of patching two or more of these effects pedals together so that the final output is a combination of the original recording and the effects stacked on top of it. Combining pedals together can create a very unique, distinct sound and when used correctly can sound very pleasing to the ear.
- Effect stacking can also be done through the means of a software that can apply and stack effects to a loop, such as the combination of a DAW and VST

Live-looping Hardware

Boss RC-300

- The BOSS RC-300 is a top of the line Loop Station. Record, playback, and control three separate stereo tracks, each with transport-control footswitches. RC-300 also features a master expression pedal, a 3-channel mixer, dedicated volume knobs for each channel, 16 onboard effects optimized for looping, and MIDI I/O.
- Strengths:
    - The internal memory can support up to 3 hours of continuous music to the internal memory with effects added.
    - USB connectivity, XLR input, and 2 x Instrument, 1/8" (Stereo) inputs make the device functional for many types of input.
    - USB port allows for easy downloads.
- Weaknesses:
    - Lack of a visual user interface is not friendly to beginners
    - Design only allows 3 tracks to run simultaneously
    - Additional footswitches are still required for full hands-free operation
- Takeaways for our project:
    - We may have to sacrifice functionality if we want to increase ease of use and to appeal to the non-pro player

Live-Looping Software

Ableton's Live-looping

- Ableton's live looper is one example of the many software based loopers. This looper is basic, but standard with all the functionalities of a loop pedal.
- Features include: recording, playback, clear track, undo, pitch shift up to 3 octaves above & below, in semitone intervals, reverse, double length, and halve length
- You are also able to quantize the loop to the current BPM, or have it set the tempo depending on your signal. It can also mute the input, so the channel only plays back the loop, not the input signal when recording with a live instrument or midi controller.
- You can run as many loopers as you like, (depending on your CPU power) and can have them on separate tracks, or on one track inside an effects rack.
- Strengths:
    - As long as your CPU can handle it, you can run as many looper tracks with as many effects on those tracks as desired
    - Pitch Shift, Double Length, Halve length, Reverse
- Takeaways for our project:
    - We will have to scale the amount of effects we that can be applied using our device in accordance to our CPU power
    - Most loopers have a reverse functionality

Effect stacking Software

Guitar Rig (and RigKontrol)

- Guitar rig is an amp and effects modeling software package developed by native instruments. Primarily designed for electric guitar and bass, the software uses amplifier modeling to allow real-time digital signal processing in standalone and studio (VST/DXi/RTAS/AU) environments
- Guitar Rig Pro offers 54 modeled stomp boxes and effects from foot pedals to complex studio tools. These effects can be used on guitars, vocals, synths, drums, etc.
- The Guitar Rig environment is a modular system, providing capabilities for multiple amplifiers, effects pedals and rack mounted hardware. The software simulates a number of devices such as preamplifiers, cabinets and microphones.
- The system allows customization of module parameters – either through manipulation of the graphical interface, use of a MIDI controller or employment of the RigKontrol foot control pedal. Settings can be saved as presets and exported and shared with other users.
- RigKontrol is a foot-operated USB and MIDI controller that is directly compatible with with the guitar rig software. It contains an audio interface and Direct box, allowing integration with live sound environments.
- The RigKontrol device can operate Guitar Rig using its' eight switches and an expression pedal.
- Strengths:
    - Effects can be applied to any instrument
    - Modular design
    - Can be operated in many different environments
    - 54 modeled stomp boxes
    - Preset browser
- Weaknesses:
    - Quality of effects might be questionable, may not have the same authentic sound as hardware
- Takeaways for our project:
    - The modular design allows for Guitar Rig to be operated solely by the RigKontrol controller if desired.
    - The audio interface and DI (Direct Box) allows for integration with live sound environments.
    - The preset browser is also something to take note of, this would increase ease of use for beginners.

Looping and effect stacking hardware

Boomerang III phrase sampler

- Boomerang III is a guitar looper and effects pedal that features four loop tracks which can be played in tandem with many effects as well as unlimited stacking. Boomerang III is made for solo performers who want complex sound or for users wanting to create experimental new sounds with a wide array of effects.
- Strengths:
    - Great for live performance
    - Great synchronization
- Weaknesses:
    - Has limited memory, cannot run pre-recorded tracks
- Takeaways for our project:
    - Keep in mind who are target users are and implement functionalities based on what would appeal to those users. The Boomerang is a good example of a looper that works well for its intended audience.

Digitech Jamman Solo XT Looper

- Digitech Jamman Solo Looper is a pedal that is friendly toward the beginner guitar player. It offers two play modes for recording:
    - “Free Form” looping style, where the loop is set according to the timing of your pedal-presses. In “Free Form” style, you’ll need no instruction, simply choose a location for the loop and tap the pedal to start looping! There’s a color-coded LED light to tell you whether you’re recording, playing or overdubbing.
    - “Auto-Quantized” looping, where you receive some assistance from the pedal to keep everything in time
      To activate the quantization feature, you simply have to dial in a tempo before you start playing. You can either do this by going into the menus and manually dialing in a BPM, or by simply pressing the “Tempo” button and then tapping the pedal in your desired beat. The rhythm guide will start playing, which you can turn up or down using the “Rhythm Level” knob. If you hold the footswitch down you can remove the backing, or you can leave it playing if you want a guide (there are nine different options if you want to change the sound). The process is pretty much the same as recording free-form, except that you get a one-bar count in before you record. If your timing is a little off on your pedal presses, the pedal will stretch or shorten it to keep everything in sync. The “Time-Stretching” feature comes alongside the quantization. This allows for the user to edit a recorded a loop to play at a faster/slower speed.
- Strengths:
    - Undo and redo feature
    - Time stretching
    - Many options for playback and stopping
    - 2 types of play modes

- Weaknesses:
    - The onboard memory is good for 35 minutes of stereo looping, but there are many options out there with much more memory.
    - It's not ideal for live use due to the single pedal (different combinations of pedal presses and holds call up other functions like stopping and undoing which may increase chances of a miscue)
- Takeaways for our project:
    - The Auto-quantize feature and rhythm guide may be something worth looking into for our project. This feature would be great for beginner players.

Bluetooth enabled pedal boxes/effects software

Zoom MS-100BT MultiStomp Guitar Pedal with Bluetooth

- User interface and backlit LCD screen make programming intuitive and straightforward. Its stereo input jack accepts signal from passive and active guitars, as well as from line-level devices such as electronic keyboards and other effects processors, and its dual line-level output jacks enable you to record many sounds in stereo.
- The MS-100BT allows you to use up to 6 effects simultaneously. You can also chain effects together in any order you like—important because an overdriven chorus sounds quite different from a chorused overdrive.
- MS-100BT provides 50 areas of memory where you can store edited and chained multi-effects as patches (user-created presets).
- MS-100BT also provides an option to create a custom list of up to 26 patches for the MS-100BT to cycle through as you step on the foot switch—handy for live performance. This list can be reordered or erased at any time.
- The MS-100BT has a built-in chromatic tuner that supports all standard guitar tunings—even drop tunings of up to 3 semitones. When activated, the LCD immediately shows you whether the note you're playing is sharp, flat, or dead on. You can opt to either bypass the currently selected effect when tuning, or to mute the signal altogether, allowing you to tune in silence.
- Tempo can be set in real time by either tapping a knob or the foot switch, providing you with instant synchronicity.
- The MS-100BT Auto Save function ensures that every edit is automatically saved. Edited patches can be named, and can be stored in any memory area, allowing for convenient storage.
- Strengths:
    - Can use up to 6 effects simultaneously
    - LCD screen interface
    - Responsive tuning/ Many tuning features (chromatic tuning)
    - Auto-Save functionality
    - Ability to chain effects in specified order
    - Can save user-created presets
- Takeaways for our project:

    - Bluetooth connection
    - Tempo and chromatic tuning features of the MS-100BT are great teaching tools for helping users that are not familiar with these concepts
    - Certain effect combinations will be made useless if they are not able to be applied to the sound in the correct order

Hotone XTOMP Bluetooth Modeling Effects Pedal

- This stomp-box can be transformed into over 140 different classic, vintage and modern effects for guitar, bass and more. The XTOMP mini uses a mobile app (iOS and Android) via Bluetooth or a desktop app (Windows and macOS) via USB with an ever-expanding effects library to load your favorite tones into the pedal. Both apps are designed to easily manage your tones, including loading effects and firmware updates into the pedal via Bluetooth (mobile) or USB (desktop).
- To simulate effects, the XTOMP mini utilizes advanced Comprehensive Dynamic Circuit Modeling (CDCM) technology. CDCM, which processes various incoming signals dynamically, is unlike current modeling systems that use the same modeling circuit regardless of the signal. CDCM allows for larger and more complex modeling algorithms, which equal more realistic and natural tones. This results in authentic-sounding effects.
- Strengths:
    - Large model/effects library, and 50 original effects
    - Buffered bypass On/Off footswitch (100% pure analog signal path)
    - Mobile App
- Takeaways for our project:
    - Bluetooth connection
    - We may want to investigate modeling technologies like CDCM to do our effect modeling

Proposed Solutions

We narrowed down four possible solutions that would satisfy the intended user:

- Looper
    - Loops playback recorded on start and stop along with ability to loop backwards
    - Ability to record multiple loops in parallel in the form of layers
    - Ability to save current loops and load previous saved or downloaded loops
- Super Tube Amp
    - Digitally replicates the distortion effect of a tube amp
    - The sound processing hardware combines analog tube amp and digital technology
- Special Effects Recommendation Software
    - Iterates through many combinations of effects on sounds and identifies possible good combinations
    - Utilize machine learning to analyze existing sounds and music
- Effect Stacking
    - Connects to existing guitar effects pedals and can change effect levels
    - Change order or settings of pedals without physically reordering them
    - Ability to manipulate effects remotely and quickly

Assessment of Proposed Solutions

As a group, we took the Proposed Solutions from earlier in the document and decided to make a combination of almost all of them (The Tube Amp excluded). This can lead to all sorts of benefits but also possible detriments. For starters, a solution with such a broad scope makes it less focused on one particular aspect and as such may be inferior to a more focused solution in a particular area. However the strength in this design is that we can accomplish one of our main goals: “Making the process of looping/sound effect manipulation easier for the average consumer”. Having so much functionality means that as a group we must be careful in selecting hardware (and software) that will be capable of supporting so much functionality. This has been taken into consideration as mentioned in the “Risks and Challenges” Section in which such capacity concerns are addressed.

Our solution hopes to achieve singularity in being a device that not only allows the user to accomplish so much without the need of multiple devices, but is also easily usable by even inexperienced users. This itself will provide a road block later on as the design must be able to incorporate all of our ideas while still maintaining that simplicity we hope to achieve with a visual representation in the LCD screen. Through countless design drawings from our group, we all came to agree that this solution was optimal as it is making musicians lives easier, containing lots of varying functionality, and is still feasible.

High Level Block Diagram

Below is a block diagram detailing the interconnectivity of the environment our product will function within.

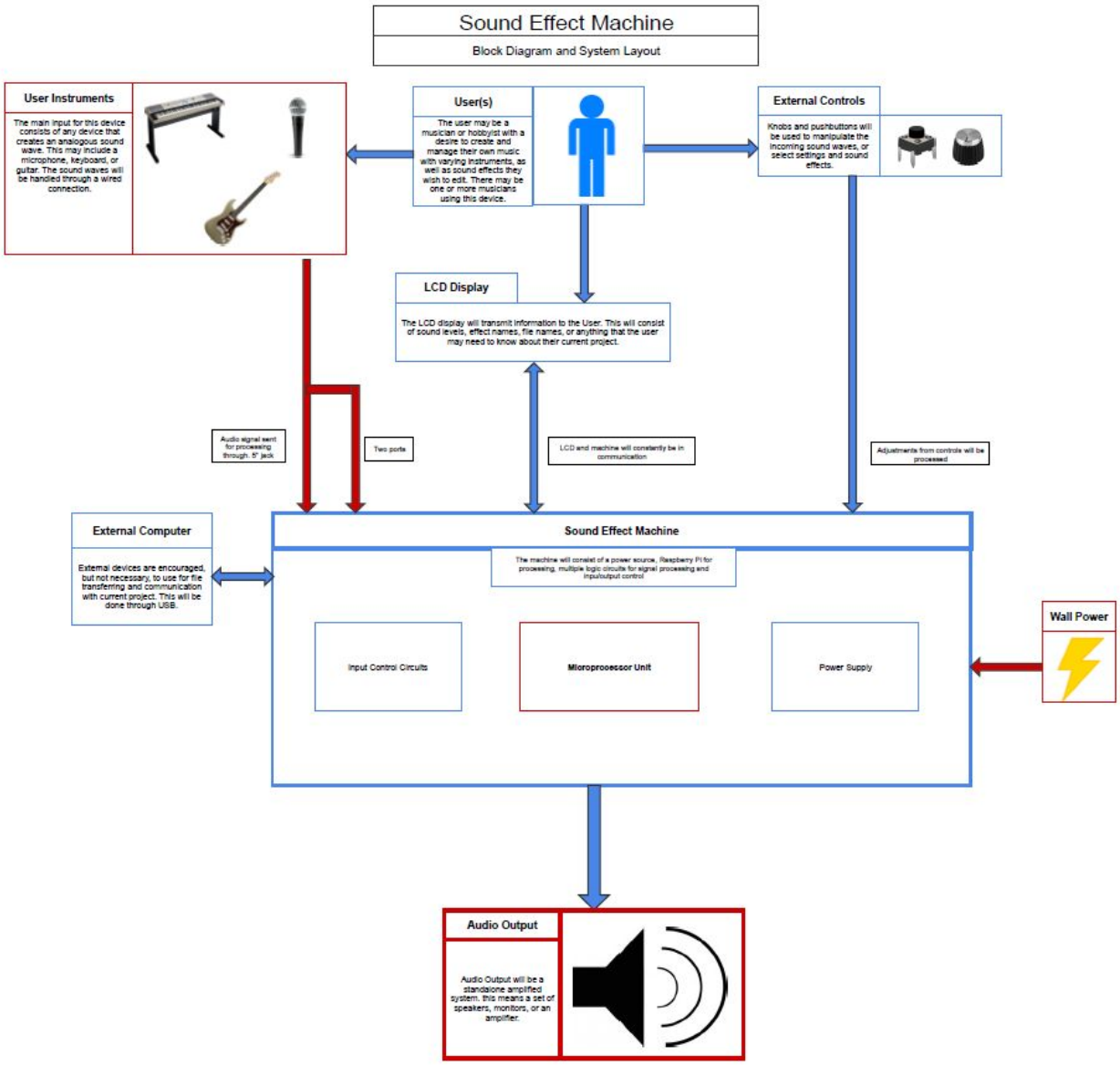

Figure 2: Block Diagram

Testing Requirements Considerations

Validation and Acceptance Test

First to address the testing we must define what functionality the user expects in the product.

The user expects to be able to:

1. Edit their music with many different types of sound effects
2. Mix together sound effects
3. Record music
4. Replay/Loop
5. Stack Loops on top of each other
6. Use pedal to control sound effects
7. Visualize the sound effects through a UI both in the software and on the pedal itself
8. Be compatible with standard I/Os for musical instruments

Test Plan

Now we have to test each of these requirements to make sure the user is able to do these things.

We will test the above requirements with the following tests:

1. Use the product in person with standard musical instruments owned by project members and confirm success and variety of sound effects.
2. Experiment with the product's sound effect mixing and assure that there aren't bugs in mixing types. Also created automated tests that run through combinations to ensure there are no bugs.
3. Test the limits of the recording process, i.e. keep recording for as long as possible, create test recordings to see how long of a recording can be stored, etc.
4. Perform replays of the recordings and listen to the audio and analyze the audio to ensure it matches the recording.
5. Once again we need to prove that we can stack loops to create diverse sounds but then create automated tests of stacking multiple loops and making other sound effects to ensure there are no hidden bugs.
6. Since almost all group members are musicians (and also have contacts that are professional musicians) we will want to use them as test subjects and record their feedback to ensure that the pedal is effective while playing music.
7. Verify the working UI corresponds correctly to each physical configuration on the pedal to ensure no bugs.
8. Test multiple standard I/Os in the musical market right now on the device and ensure proper compatibility.

Safety Considerations

This project will follow the IEEE Code of Ethics:

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to be honest and realistic in stating claims or estimates based on available data;
4. to reject bribery in all its forms;
5. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;
9. to avoid injuring others, their property, reputation, or employment by false or malicious action;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Possible Risks and Risk Management

Below is a risk assessment of the potential challenges we will come across as we are developing our design. The biggest hurdle that we will foreseeably have to address is the capability of the controller. The onboard controller must have the adequate hardware resources to handle multithreaded sound process and raw audio manipulation. This will require a powerful processor and ample RAM. We hope to mitigate this problem with efficient software and intelligent design.

Risk	Risk Description	Risk Impact	Probability of Occurence
RAM usage and capability	We are currently looking at a RaspberryPi as the primary controller for our device. The highest model is the 3B+, which has 1GB of RAM. Since we are planning on having four layers of effects, we will be doing four times worth of audio processing. A problem could arise where the amount of RAM is too low to handle this kind of load. It is currently not possible to add more RAM to the rPi.	High	High
Processing power not being enough	Along with the RAM usage, the audio processing also puts load on the Raspberry Pi's processor. The Raspberry 3B+ touts a Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz processor. It could be the case that once we test the software component, we find that the processor is not enough to handle what we need it to.	High	Low
Making system versatile without overcomplicating user interface	We want our device to be able to do many different tasks and act as a "One Stop Shop" for the musician user. However, we do not want a user interface / experience that is confusing or slow to use. This creates the challenge of providing an interface that is easy to use on stage, but that presents the user with a powerful, diverse toolset.	Medium	Medium
Lack of hardware knowledge	The realm of audio processing hardware is new to our group members. On top of that, we only have one Electrical Engineer on our team, who will carry a lot of the weight of the hardware implementation. This presents our entire group with the challenge of researching and selecting hardware that properly meets our needs.	Low	High
Cost of materials and budget	As this project is open to creative decisions, the budget for the project will likely shift and change throughout development. This fact combined with the hardware knowledge risk means we will only know estimated cost once we've decided on certain components that will be needed for the device to function. The cost of the project is both a risk and a challenge.	Medium	Low

Table 1: Risk Assessment

Estimated Resources

This analysis is clearly a rough estimate. Much refinement is needed to cut costs and optimize our device. The assumptions for this project's costs were that we would use prefabricated materials, and use a basic microcontroller. Further component selection is needed in order to cut costs.

Sound Effect Machine				
Bill of Materials				
Item	**Quantity**	**Price**	**Source**	**Details**
Rotary Encoder Illuminated	13	$4.95	sparkfun	Illuminated knob that infinitely turns in 2 directions. Also has pushbutton function.
Rocker Switch (Power)	1	$6.95	sparkfun	Illuminated knob that infinitely turns in 2 directions. Also has pushbutton function.
Expression Pedal Kit	1	$22.95	Small Bear Electronics	A fabricated shell for a guitar pedal. Requires assembly and electronic parts
Hot Potz	1	$25.00	Pedal Parts Plus	A push down potentiometer for footpedals
Springloaded Pedal	2	$9.03	Amazon	Just need the shell. Insides will be gutted to fit our needs.
Spring Kit	1	$3.95	Small Bear Electronics	Spring for expression pedal
Footswitch boxes	2	$19.95	Small Bear Electronics	2 x 2 button stomp pedals for 4 button pedal ban.
Raspberry Pi	1	$39.95	sparkfun	Microcontroller
ADS1015	1	$9.95	adafruit	ADC for use with Raspberry Pi, it inputs up to 4 analog signals. 12 pit precision
Graphic LCD 128x64 STN LED Backlight	2	$23.95	sparkfun	LCD display
X-Wing DPDT Switch Bent Lug	3	$2.95	Pedal Parts Plus	2 stomp buttons to go underneath the springloaded pedals, and 1 for the mode toggle in button bank
Power Jack DC	1	$1.51	Pedal Parts Plus	Input from wall
12V Power cord	1	$7.99	Amazon	Power cord
MIDI In/Out (4 ct)	1	$6.99	Amazon	MIDI in and out ports
1/4" Stereo Jack	4	$1.65	Pedal Parts Plus	input from microphone, input from guitar, output L/R to speakers
3.5mm auido jack (2 ct)	1	$7.99	Amazon	input and output for tracks, or for headphones
XLR Jack	1	$3.17	Amazon	For microphone option
Total	18	$257.71		

Table 2: Estimated Resources

Project Timeline

For our project we needed to create a timeline to help us better be prepared and provide us a guide to follow. The better this timeline is, the more likely it will be easier to accomplish our goal. When creating this project timeline, we had to really break the project down and categorize what different parts there were in the project. Three of the biggest sections we found are the hardware, the user interface, and the connections between the two (API). As a group, we managed to discuss the type of process we would like to have moving forward. Being that there is a lot of research to be done, we wanted to use the Proof of Concept (POC) approach. By having members perform extensive research on certain topics, we can cover more ground. When someone finishes research, they are to be comfortable enough to share a synopsis of the research to the rest of the group while making a clear and decisive suggestion on whether the technology or idea researched would be ideal for our project moving forward, thus allowing us to not waste time during the research phase. We also provided time for much testing and refining at the end of the project's timeline to ensure a quality project in the end.

ID	Task Name	Predecessors	Duration
1	Start		0 Days
2	Decide on Controller	1	7 Days
3	POC on other hardware	2	14 Days
4	POC on conversion method for analog to digital	2	21 Days
5	POC on main language used for project	2	7 Days
6	Buy hardware and connect to system (rough draft)	3	21 Days
7	Implement conversion methods for Analog to Digital	6	21 Days
8	Design code base library to be used for project's software	5	21 Days
9	POC on power options for the unit	6	7 Days
10	POC on file types that we will store in db	7	7 Days
11	Design database based on the API	10	7 Days
12	Create connections to database from software usingAPI	5, 10	7 Days
13	Install power management	9	7 Days
14	Draft first enclosure for the device	9	7 Days
15	Draft UI design	8	14 Days
16	Implement drafted UI	15	28 Days
17	Draft Tests for API connections	12	7 Days
18	Poll people on our enclosure draft	14	7 Days
19	Poll people on our UI	16	14 Days
20	Refine enclosure upon research completion	18	14 Days
21	Refine UI based upon research gathered	19	21 Days
22	Draft tests for UI	21	7 Days
23	Perform final research on the newly constructed research	22	7 Days
24	Refine prototype and create final product	23	21 Days

Table 3: Project Timeline

Conclusion

Cyren will be used by musicians all over to create unique sounds with our sound effect system combined with multiple loopers that can be layered over one another. We as a group envision Cyren being used by a multitude of users, from beginners to experts, we want to provide a product that will find use for almost any guitarist looking to add looping or sound effects to their music. Our design is well constructed and follows IEEE guidelines. The project itself has been iterated upon countless times to reach the optimal solution and as a group we are quite pleased with the end result and are excited to start working on development. We hope to provide with this document the level of planning necessary to fill in any gaps in understanding and make Cyren a reality.