Hybrid Synthesizer

Project Proposal
Senior Design I
EEL 4914

Group 32
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Project Description

In the world of music, various electronic devices have made their way into halls of fame for their particular character or beloved versatility. This naturally extends to synthesizers. There have been a variety of analog and digital synthesizers made available to the market. They can run utilizing analog components, software signal generators, or reference sampled sound libraries to create a wide array of sounds. While the instruments are fascinating and have become an important addition to most modern music, they are also prohibitively expensive to acquire. When a decent synthesizer costs $1000 on the low end, it is already a stretch for most consumers. On top of that, most synthesizers only create music using one approach (analog circuits, virtual instruments, sampling), meaning it is even more prohibitive for an individual to really get a feel for which synthesizer is best worth the investment for the sound the artist wishes to create. Additionally, most synthesizers are large and cumbersome, making them non-ideal for travel or live performance.

The synthesizer our team wishes to create would be a small hybrid synth, in that it would utilize both analog circuitry to create classic electronic sounds as well as a software environment that can simulate various well-known instruments, and even allow the user to sequence a series of notes on repeat so they could tweak and mix the presence of various aspects of the wave's character (such as the presence of sine, square, triangle, or sawtooth waves, or the shape of the ADSR envelope). Additionally, the synth would be light, small, and portable. To save further on implementation, a custom coded keyboard application that can run on an android phone would be connected to the synth via USB, allowing the user to play real-time or sequence notes for playback either through instrument virtualization or through the analog components. This would allow the synth to retain a small profile while also enabling it to serve as a sort of audio playground, where the user could experiment real-time to get the most out of the sound.

The box would be aimed at being an affordable alternative to multi-thousand dollar synthesizers, while still providing an all-in-one quality sound synthesis source for artists with tight budgets. It would have ¼" line out to be plugged into an audio interface for recording or a speaker for live playback.

Specifications

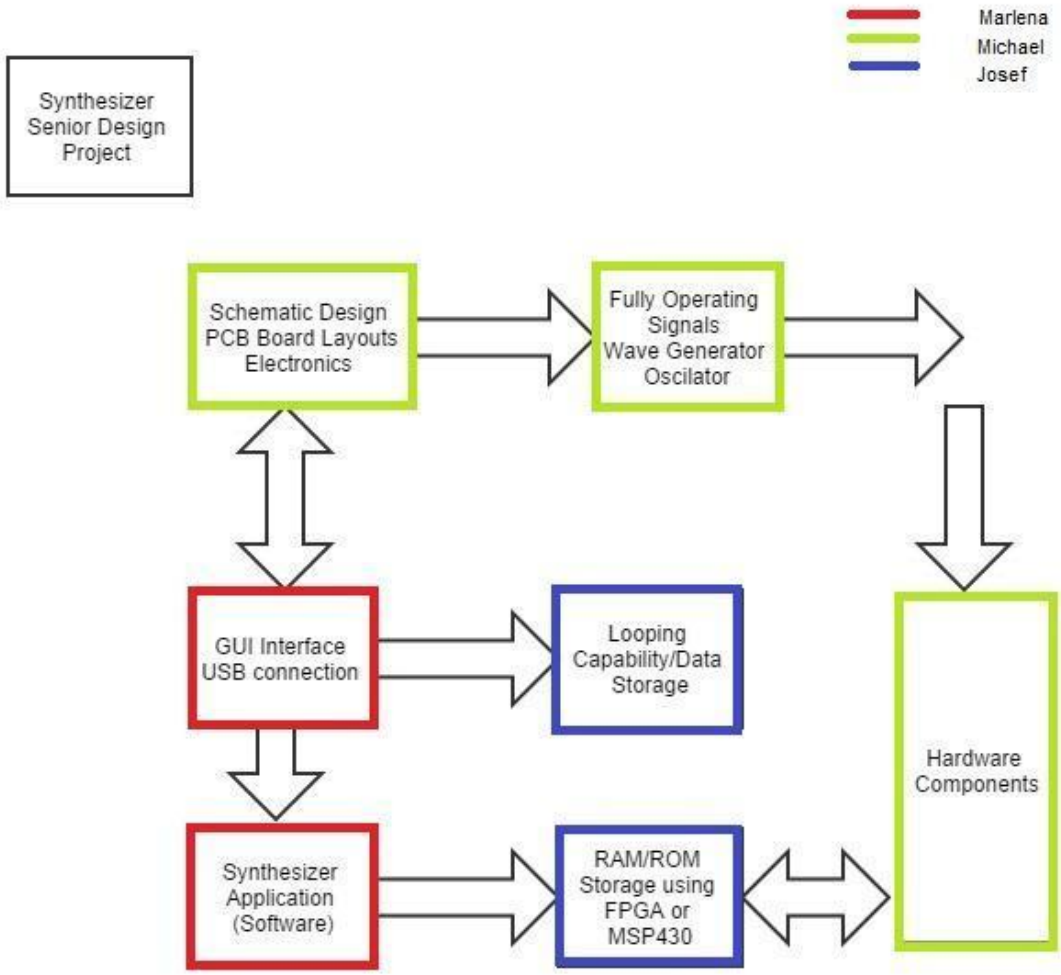
- Needs to be light, ideally ten pounds or less
- Must be at least monophonic for at least two octaves in the analog design
- Must support at least 3 waveforms in the analog design that generate a consistent, reliable signal
- Must support at least 3 common orchestral instruments in software synthesis (piano, flute, clarinet, etc)
- Must support either plugging in an android phone with custom keyboard application, plugging in a USB keyboard, or having a physical keyboard designed (whichever is better to implement for the design)
- Must disperse heat well and ideally consume relatively low power

Additional Goals (to be supplemented or removed as necessary based on what is best for the design)

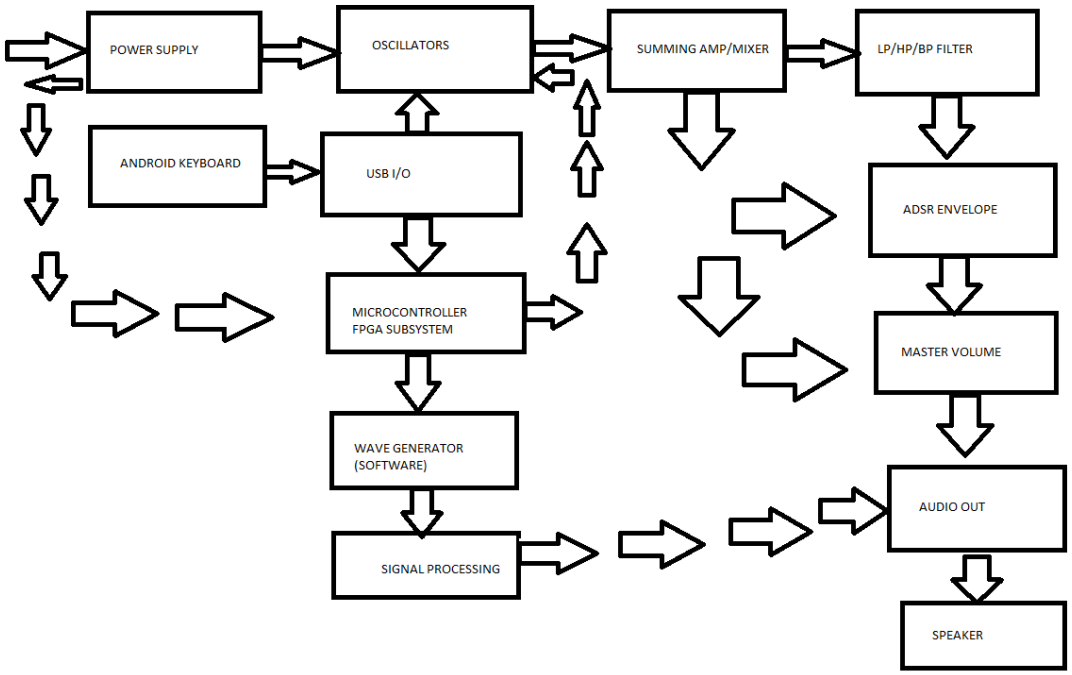
- Have four or more unique signal generators in the analog system that can be mixed real-time using a summing op-amp
- Have a basic envelope (2+ stages) to shape the analog sound
- Have a basic lowpass/highpass/bandpass filter that can be swept across the analog sound
- Have some form of LFO that regulates tempo or other aspects of design
- Have a sequencer, either in hardware or software, that allows the user to automate playback of notes in either the analog or virtual instrument domain
- Consider battery power for extreme portability
- Consider polyphonic sound for both software and hardware sound synthesis

Block Diagram

Task assignments may change during the research phase as deemed appropriate by the design team



Block Diagram (of possible physical implementation)



Budget

Item	Item Cost	Quantity	Total
PCB Board	$50	2	$100
Software	$100	1	$100
Hardware	$150	1	$150
Keyboard(for parts)	$100	1	$100
Power Supply	$50	1	$50
USB Cable Interface	$10	1	$10
			$510

Project Milestones

Start Date: NOW **Due Date: May 5th** **Work Duration: 9 month project**			
Hardware	Software	Design	Trouble shoot
Values	Goals	Money	Schematics
Envelope	Components	Microprocessor	FPGA
Source Code	Sensors and Actuators	Integrated Circuit	Signal Transmissions
GAIN	Damp DISTORTION	Noise to Signal ratio	Bandwidth
Frequency	Data storage	Playback features	Speaker output Battery input
Funding	Musical capabilities	Fpga	MSP430
Questions	Processors	Graphical User Int.	Schematics

Month 1 – September – The Research, the Funding	
Hardware Research	Schematics, FPGAs, Components
Software Research	GUI interface, codes
Troubleshooting	Contingency Plans

Month 1 – October – The Designing and Refining	
Hardware Design	Amplifier Circuit
Software Design	Simple GUI Interface
Serial Communication	Wireless or Wired?

Month 3 – November Testing One+ Component Circuit Board Vs Gui	
Gain Level Display	Loop
Deep Signal Capture	Modulation?
Gui Test Run	Small LEDS as needed

Month 4 – December – Independent Research	
Josef	Marlena
Michael	

Month 5 – January – Design#3	
Simplify Circuit Design	Power Efficiency Ratio
Signal Transmission and Modulator	Optimize Circuits for quality and performance
Test and integrate new features as necessary	

Month 6 – February – Testing + Verification	
PCB Board Design Order	Effect Implementation
Collect Possible Funding	Playback checkpoint
Data Storage Checkpoint	

Month 7 – March – Upgrades and Extra Effects	
Schematic	Test Running Source Codes
Timers, Additional Modules, Functionality	LED Flashes

Month 8 April – Prepare Design Display and Presentation	
Overall Look	Adaptability towards Judges
Overall Strength of Project in terms of Course Content	Demonstration of Project
Scientific Aspects of the Clocks and Pieces Involved	Q&A

Final Month 0 May	
Present the Design	
	Celebrate