Check Out Our Soundcloud: A Wavetable Synthesizer

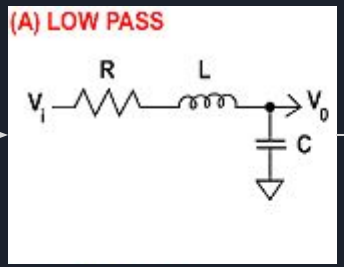
Team A0
Jens Ertman
Charles Li
Hailang Liou

Problem Statement

- Software Synthesizers
  - Interesting wave manipulation features
  - Trapped in computer audio environments
- Hardware Synthesizers
  - Cheap and missing core wave manipulation features
  - Expensive with full feature set

Our Solution

An FPGA based synth that focuses on the specific feature of wave blending and shaping, and comes with a feature set similar to a less expensive synth while offering a few core features available in much more expensive synths



Our Solution

Analog and Digital (with Signals all over)

- Digital
  - Better parallel signal processing
  - Allows for more complicated effects
- Analog
  - Higher quality filter effects
  - An important highly marketed feature of high end synths

Requirements

Features
4 note polyphony
Multi-wave blending with 4 wave shapes
Unison and PWM effects
Reverb and delay effects
Bit manipulation distortion
Analog EQ and filters

Requirements
Produced notes within ±5 cents of standard
Total harmonic distortion less than 5%
Frequency response less than 5% deviation
Latency variation less than 1% deviation

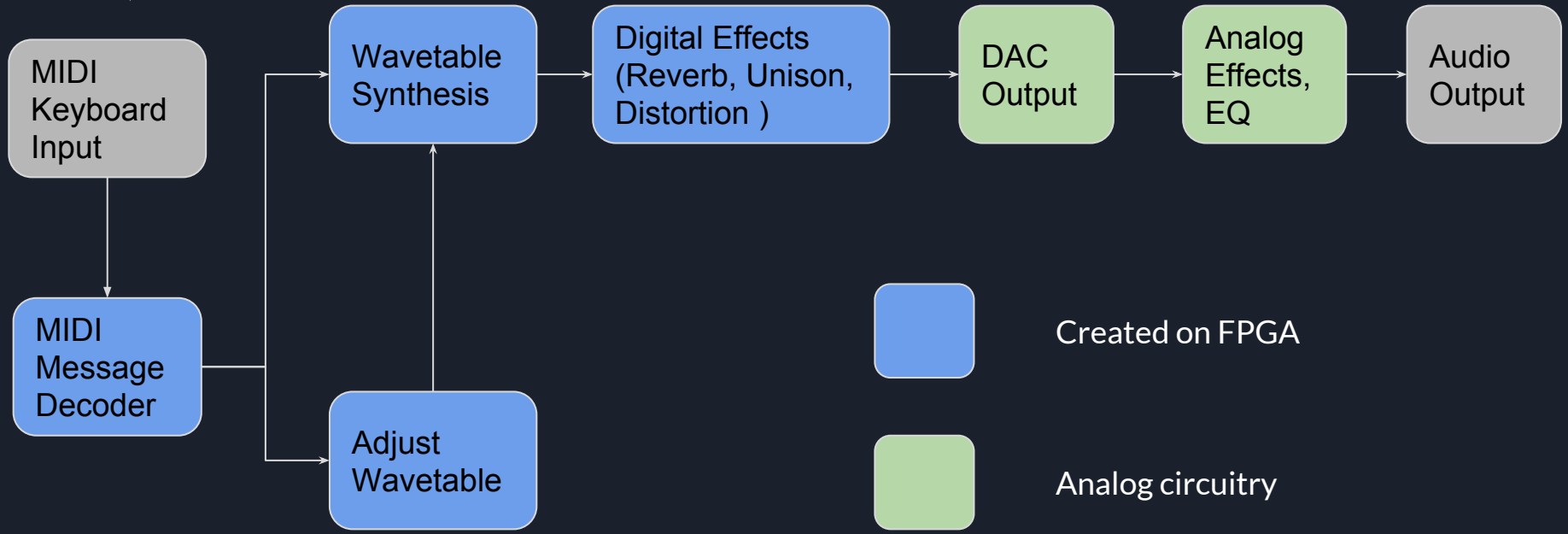
Challenges

- Interfacing between hardware
  - Between the MIDI controller and the FPGA
  - Between the FPGA and the DAC
- Amplitude levels of signals not getting too large or small while effects are being applied
- Design and implementation of waveform blending and shaping
- Collecting the data from the oscilloscope for testing and verification

Implementation

- MIDI controller to drive signals for note and effect control
- An FPGA to design the effects and synthesis logic on
- DACs to convert the signal back to analog
- Filters to sculpt the final signal
- Amplifier to raise the signal to a proper output level

Block Diagram



Verification methodology

Requirement	Testing
Effects	Testbenches to confirm behavior
Note pitch	Use an instrument tuner
Distortion	FFT across using oscilloscope
Latency	Measure cycle count from input to output
Frequency Response	Compare the output levels all notes
Filters	Generate Bode plots

Metrics

Other metrics:

- Total power/area
  - Minimize wavetable size while maintaining fidelity
- Overall parts cost
  - Maintaining a price point that is competitive with alternatives

Task list

Jens	Charles	Hailang
MIDI message decoder	Analog filter design	MIDI-FPGA interface
Wavetable incrementer	DAC support circuitry	Delay Effect
Wavetable blending	Unison mixer	Reverb Effect
Amplifier design	FPGA-DAC interface	Bit distortion effects

Proposed schedule

		Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		2/3-2/9	2/10-2/16	2/17-2/23	2/24-3/2	3/3-3/9	3/10-3/16	3/17-3/23	3/24-3/30	3/31-4/6	4/7-4/13	4/14-4/20	4/21-4/27	4/28-5/4	5/5-5/11
	First Status Report		A												
	MIDI Serial to 3 Byte MIDI Code Decoder	H	H												
	3 Byte MIDI to note and effects control signals	J	J												
	Analog Filter Design and Implementation	C		C											
	DAC Design and Implementation		C		C										
	Design Presentation/Document			A											
	Wavetable Incrementer				J	J									
	Wavetable Mixer					J	J								
	Unison Mixer						C	C							
	Bit manipulation distortion								H	H					
	Stereo Delay				H	H									
	Reverb					H	H								
	DAC Pre Prep module							C	C						
	Midterm Demo									A					
	Amplifier								J	J					
	Integration/Testing										A	A			
	Final Presentation Preparation													A	
	Final Report													A	A
Task	Slack			H/J		C		H/J		C			A		