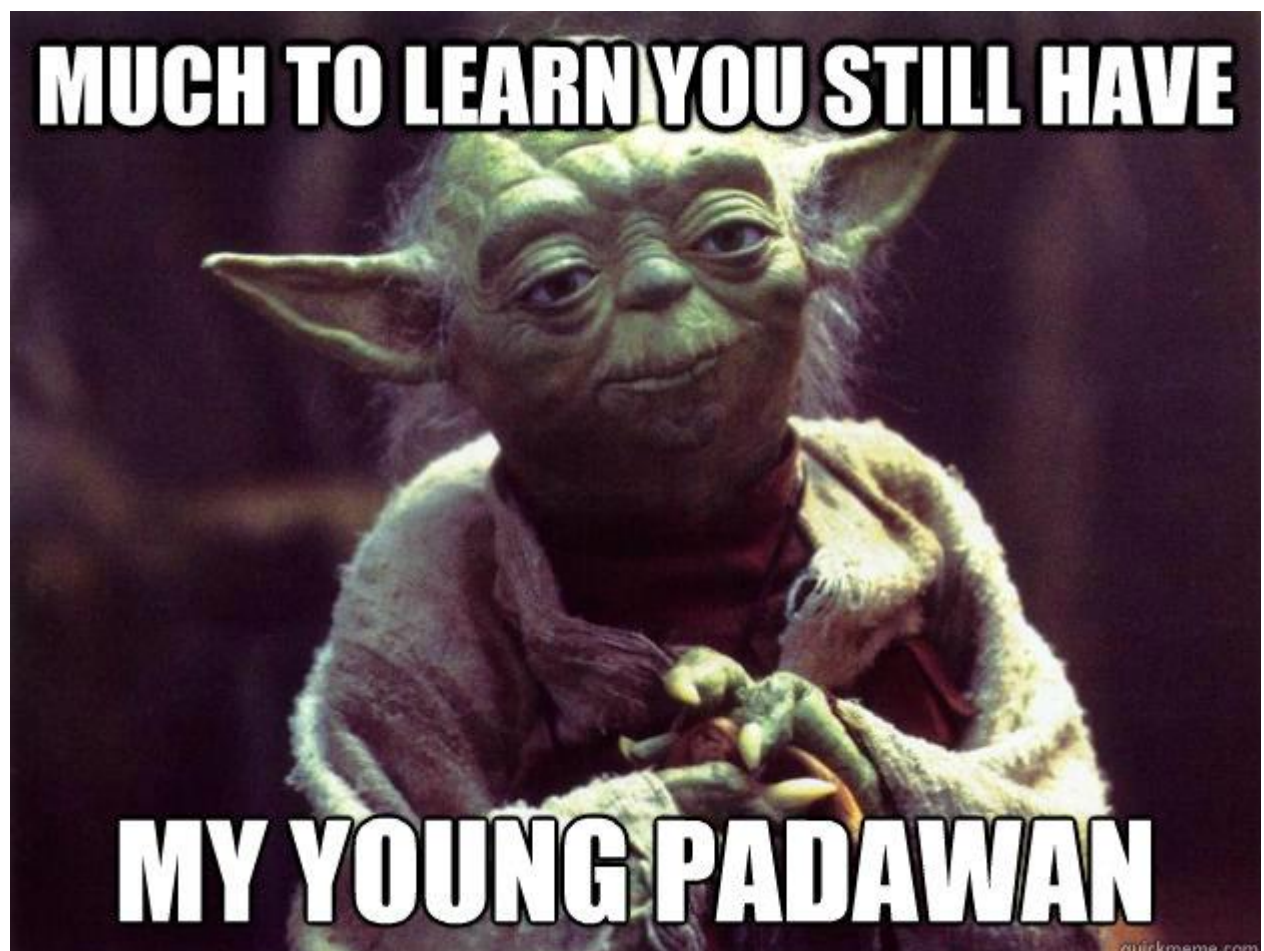# PARALLEL ACCELERATOR FOR DIGITISING AUDIO WITH ATTENUATION OF NOISE

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Project Description

This project aims to perform filtering and processing of audio in near real-time using an FPGA, specifically the Nexys 4. The PADAWAN system is provided with a digital audio stream on which real-time filtering can be performed using parallel filters to achieve various effects such as echo, vibrato, treble and flange [1].

Filtering will be performed using discrete-time convolution of the input stream and a discrete transfer function, specifically using the FFT for faster convolution. Essentially, the output sample will be a weighted sum of current and previous samples representing the filter transfer function. Noise shaping will be performed using dithering. This is the process of adding white noise to the output to reduce the effects of quantization error and increase the perceived bit depth of a signal [2]. Audio effects will be implemented using a variety of different methods. For example, flanging will be implemented by adding delayed samples to the output, where the delay period is continuously variable. For the echo effect, a constant delay will be used, with a minimum time of 35 milliseconds, to make the echo perceptible [3].

Thereafter, output of filters will be summed into a single output stream and then converted to analogue by means of pulse width modulation (PWM). Sanguinely [4] the tap-weights and effects of the various filters will be made variable in real-time by means of potentiometer inputs.

Prototype Specification

- A digital audio stream will be fed to the FPGA through a connection to a PC.
- Filters will be implemented in software on the Nexys 4 FPGA chip using the FFT algorithm.
- Several filters will be made adjustable by means of a potentiometer to allow the user to customise sound effects.
- A noise shaping filter will be implemented prior to output, to give the impression of increased resolution.
- The output of the noise filter will be outputted via PWM and finally played through a speaker.

Criteria for acceptable solution

- Starts up
- Filters cause desired effects
- Potentiometers cause desired variations to specific effects
- Noise shaping filter improves quality
- Able to output sound through speaker via PWM

Bibliography

[1]   'Realtime audio processing, part 4: Comb filters, Flangers and Chorus effects – a bit of theory | philippseifried.com'. [Online]. Available: http://philippseifried.com/blog/2011/11/01/dynamic-audio-4-comb-filters-flangers-and-chorus-effects/. [Accessed: 19-May-2017].

[2] 'Dithering and noise shaping'. [Online].
Available: https://www.fabfilter.com/help/pro-l/using/dithering.html [Accessed: 22-May-2017]

[3] 'Audio signal processing'. [Online].
Available: https://en.wikipedia.org/wiki/Audio_signal_processing [Accessed: 22-May-2017]

[4]   'sanguinely - definition of sanguinely in English | Oxford Dictionaries', *Oxford Dictionaries | English*. [Online]. Available: https://en.oxforddictionaries.com/definition/sanguinely. [Accessed: 19-May-2017].