

# Super Efficient Real Time Pulse Convolution Synthesis with Generative Impulse Responses

The proposed novel synthesis is based on efficient real time convolution of the Variophones tri-pulse oscillators (TPO) transfer function with arbitrary spectra, using derivatives and an integration step.

This reduces the convolution of both spectra to 2 subtractions and 2 multiplications plus one 1 order lowpass filter.

Further, we propose to generate the arbitray target spectra, which can be impulse responses of real instruments, or rather their derivatives, with matching seeds for random number generators (RNGs).

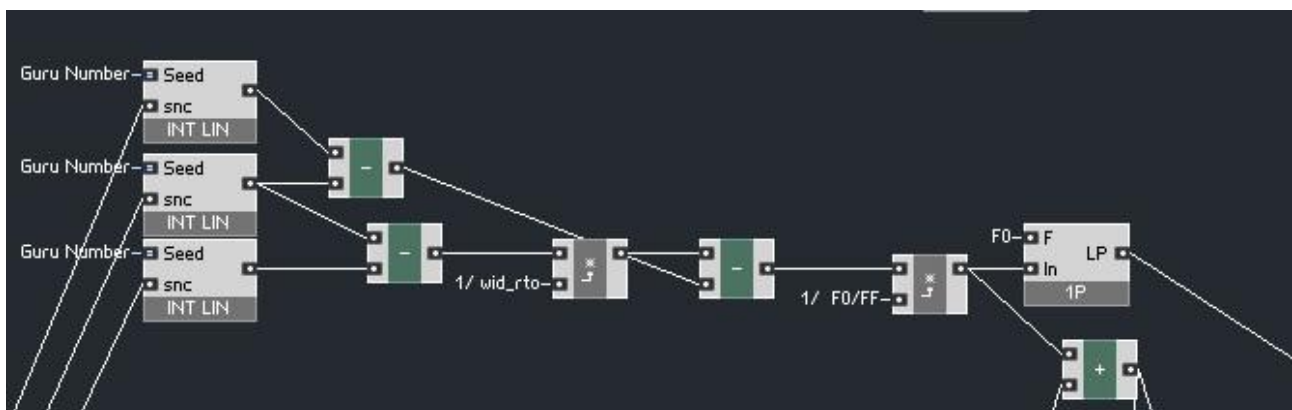
The synthesis can produce a wide range of timbres, including strikingly convincing timbres of accoustic instruments like pianos, guitars, voice, wind instruments, synthesizers, and more,

The synthesis seems more efficient than even sampling in same implementations.

## 1.

The derviative of the TPO is a 3-stepped pulse waveform. The derivative of the latter is a series of impulses seperated by zero valued samples.

Hence we can calculate the convolution between the TPO spectrum and an arbitrary spectrum by simply substracting apropiately shifted copies of the derivative of the arbitrary spectrum from itself, weighted, followed by an integration step.



(The Oscillator Core:

Left:( Derivative) Impulse Response Generators, snyched by the fundamental frequency, with phase offsets corresponding to to the TPO width and tail parameters

Mid: Convolution with the TPO function by 4 operations

Right: integration step)

2.

The arbitrary spectrum derivative signal can be - arbitrary, and of arbitrary origin, a sample of an instrument's impulse response, for instance, but also (also synched) "analog" waveforms, bandlimited impulse functions, FM, wavetables etc.

3.

The derivative of an instrument's body impulse response resembles more and more white noise with each differentiation step, that is it is highpass filtered.

RNGs, on the other hand, which are supposed to produce white noise, exhibit local fluctuations when you examine small snippets of noise.

Hence we propose to search (offline as a preparation step) for close resemblances of derivatives of impulse responses in RNGs output, and start the RNGs with appropriate seeds to produce these sequences.

Then we can use interpolated periodically synched RNGs to produce the impulse response signals in our proposed synthesis, making it more efficient than even sampling in some implementations.

4.

Using two of such oscillators, with the same TPO parameters and target response we can create identical spectral envelopes with different harmonics.



(a fully featured early prototype proof of concept example which features a static mono Lowpass on the sum which is not needed in a final implementation.)

A proposed synthesizer does not need more than

- 1 ADSR
- 1 TPO-style width and tail control, width controlled also by LFO and Envelope
- 1 mono LFO which can modulate the width and pitch
- some detuning parameters for a second oscillator
- a selector for the base spectrum
- optional a shift control that can shift the target spectrum up and down

This synthesizer is not more complex than a classical Roland Juno, but allows for a wide range of timbres, both natural and synthetic, and very intuitive real time timbre control.

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