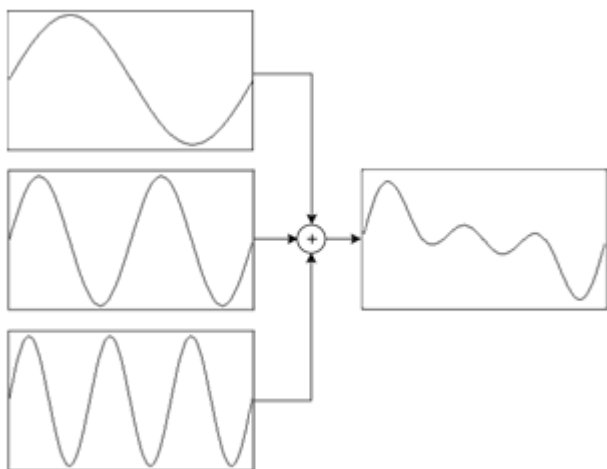


Additive Syntesis Technique

Basic concept

Additive synthesis refers to the idea that complex tones can be created by the summation, or addition, of simpler ones. Frequency "mixing" is the essence of additive synthesis. Each of the frequency components (or partials) of a sound has its own amplitude envelope. This allows for independent behaviour of these components. In additive synthesis, pure tones are added together to create more complex composite timbres. In theory, a complex timbre that has been analysed into its sinusoidal components can then be reconstructed by means of additive synthesis. Additive synthesis has the advantage that the many micro-variations in the frequency and amplitude of individual partials, that make natural sounds so rich and lively, can be recreated.



The addition of three sinewaves results in a composite wave

History

Pipe organs or Hammond organs illustrate the theory of additive synthesis because their functioning resembles the way in which additive synthesis works. The concept of register-stops of organs is very similar to the idea of additive synthesis: complex timbres result from the addition of different components to the spectrum of a sound. A giant electrical synthesiser based on identical concepts appeared in the early 1900s: the Telharmonium. The Telharmonium worked by adding together the sounds from dozens of electro-mechanical tone generators to form complex tones. This was not very practical, but it has an important place in the history of electronic and computer music. This method of generating a complex sound is sometimes referred to as "Fourier synthesis", in honour of Joseph Fourier, the mathematician who discovered the basis of what we now call Fourier analysis. Fourier analysis is the mathematical method used to break sounds down into sine waves. Fourier synthesis is the process of building the sound back up again. In the early days of electronic music, a few composers composed music based on additive synthesis alone. Micheal Koenig was one of the first composers to create apiece entirely using additive synthesis 'Klangfigures' and Kenneth Gaburo's composition 'Lemon Drops', a classic of electronic music made in the early 1960s.

Methods of Sound Analysis


In order to model spectrum of a sound, musicians need adequate means to dissect, interpret and represent them. There are two categories of spectrum analysis:

1. **harmonic:** it identifies frequencies and amplitudes of the spectrum components
2. **formant:** it uses the estimation of the overall shape of the spectrum's amplitude envelope.

Spectrum analysis is fundamentally important for additive synthesis because samples alone do not inform the spectral constituents of a sampled sound. Fast Fourier Transform (FFT) Classic additive synthesisers use oscillators to produce the partials of the resulting sound. The FFT breaks a sound up into sinusoids through a computer algorithm. It analyses the content of a sound and derives the Fourier spectrum. FFT is important for additive synthesis because it helps us to

estimate the values for the oscillators that produce the partials of the synthesised sounds. Basically it scans the input signal at rates that are multiples of its own fundamental frequency in order to estimate the components of the sound in question.

Sound Examples

 [Example 1 \[Click to hear\]](#)

 [Example 2 \[Click to hear\]](#)

 [Example 3 \[Click to hear\]](#)

Technical focus: Windowing

Strictly related to FFT analysis is the process whereby shorter portions of a sampled sound are detached for FFT analysis. In that the windowing process chops the sound in short segments called windows; so far it must be sequential, but the windows may overlap. The result of each windows analysis is called FFT frame.

The effectiveness of the process depends from three factors:

1. the envelope for the window
2. the size of the windows
3. the overlapping factor.

The size of the window defines the frequency resolution and the time resolution of the analysis.

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