INTRODUCTION TO COMPUTER MUSIC
SAMPLING SYNTHESIS AND FILTERS
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SAMPLING SYNTHESIS
Synthesis from pre-recorded sounds
Sampling Synthesis

- FM and other techniques were “big” when computation and memory were expensive.
- But FM never produced satisfactory simulations of acoustic instruments.
- Sampling is a simple concept: Record actual sounds and play them back!
- Advantages:
  - Easily captured sounds
  - Works with noise, tones, anything

How it works

- Base case: store a sound and play it back
- Desired parameters:
  - Duration
  - Pitch
  - Amplitude
  - Vibrato
  - Brightness
Controlling Duration

• Repeat a portion of sound
  • Could be a single period
  • Could be much longer segment
  • Finding good “loop points” is tricky
• Use an envelope and multiply to decay at end

Finding Loop Points

• Often done “by ear” interactively
• Tones are not often truly periodic
  • changes in amplitude, frequency, noise, spectrum
  • but you can pick where to start looping (a search problem)
  • you can cross-fade to make a smoother transition
• Periods are not always integer number of samples
  • At G₄ (391.995 Hz), 1 period = 44100/f₀ = 112.501 samples
    • Upper harmonics are of course much shorter, so cutting out even half a
      sample is significant.
  • You can loop over multiple periods.
  • You can resample (interpolate) to get an integral length
Controlling Pitch

- Resample to speed up and slow down
- Usually over limited range (2 to 12 semitones)
- Linear interpolation can cause aliasing
- Good samplers use multipoint interpolation using a weighted sum; number of points is considered trade secret

Controlling Amplitude

- Simple multiply
- Or, cross-fade between loud/soft samples
  - Cross-fades risk phase cancellation
- Can apply low-pass filter to make softer sounds less bright
Other Parameters, Modifications

- Filters for various effects
- Frequency and Amplitude vibrato is easy to add
- Reverb, chorus, other effects
- Starting sample at offsets to emphasize/deemphasize attack transients
- Notice that these are all \textit{synthesis} techniques

Problems with Sampling Synthesis

- Most of the interesting sound quality is “frozen” in the samples
- Strings and woodwinds are controlled by bowing and blowing, not so much by the passage of time – bad model
- Samples can take lots of space: modern libraries take gigabytes
Examples

• See sampling.sal