

Noisemaker Workshop

Oscillators II: Modulation

May 8, 2009

Outline

Recap

Last week, on "Noisemaker Workshop" ...

- ▶ Capacitor and Resistor + Inverter with hysteresis = Oscillation!
- ▶ Start: Input Low, Output High
- ▶ Current flowing through resistor across input and output pulls voltage up at input
- ▶ Capacitor from input to ground charges slowly as current flows through the resistor
- ▶ When the input voltage gets high enough, the chip flips to Output High state
- ▶ Buffer all this through our Amp chip and we get sound
- ▶ Varying the current in the feedback loop with Light-Dependent Resistor changes the charging speed, and thus pitch

Today

Modulation

- ▶ So say we make a second oscillator. Then what?
- ▶ First-most obvious step:
put output of both oscillators into the amp
- ▶ All you're really doing is mixing the two tones
- ▶ Yawn.
- ▶ If we could only make one oscillator change the way the other one behaves...
- ▶ Modulation!

Gating

Output of one oscillator into input of another

- ▶ What if you connect the output of one oscillator to the input of the other to make it turn off sometimes?
- ▶ Should work. But, there's a feedback path.
- ▶ Now, use a diode (one-way valve) to remove the feedback.
- ▶ First oscillator output low:
input of second never charges, no sound.
- ▶ First oscillator output high:
disconnected by diode, second oscillator free to do its thing
- ▶ When their frequencies get similar, all heck breaks loose

Diode Mixing

More diode tricks

- ▶ While we've got the diodes out... (see diagram)
- ▶ Since the diodes are one-way valves,
there's no way for Osc 1 to influence Osc 2 (or vice-versa)
- ▶ Connecting the output of two oscillators to the amplifier buffer by using diodes creates a logical OR function
- ▶ If Oscillator 1 is high *or* Oscillator 2 is high,
the output from the diodes will be high
- ▶ Mixes the frequencies in a non-linear way. Fun.

Frequency Modulation

Light-controlled Oscillator

- ▶ We already have been doing (very slow) frequency modulation: when you wave your hand over the LDR, the pitch lowers
- ▶ Your hand is moving slow enough that we perceive this as pitch changes, like a melody
- ▶ As with gating, FM starts to make new sounds when the frequency of modulation (you waving your hand back and forth) speeds up
- ▶ With the modulating signal is near the audio range, we don't hear melodies, but a change in the timbre of the tone
- ▶ But how to move your hand that fast?

Frequency Modulation

Enter the Vactrol (tm)

- ▶ A *Vactrol* is a trademarked name for an LED tied to an LDR
- ▶ We'll use the quick-switching ability of the LED to stand in for moving our hand back and forth
- ▶ (This vactrol technique is *hugely* versatile! Anywhere you can control something by resistance, a vactrol allows you to control it with voltage.)
- ▶ Setup an oscillator at a medium frequency to drive an LED
- ▶ The LED is a fairly big load for these chips: we'll need to buffer it like we did the speaker
- ▶ What's FM good for? Bells, gongs, birds, drums.

Homework

Misc craziness

- ▶ Implement any/all of the modulation ideas above that you didn't get a chance to try out
- ▶ Gating + FM: One oscillator for both gate and LED? Different oscillators?
- ▶ Ghetto VCA with diodes: feedback, wrongness

The End

[◀ Outline](#)