The multiple identities of the simple S&H PLL synth …

We have already seen how we could extend the simple phase locked loop control circuit with a resonator to a rough abstraction of an acoustic musical instrument. No matter how simple, the essence: interaction between driver and resonator formed the heart of this virtual instrument.

The same interaction ensured that many distinctive sounding realities could be formed from that one simple model. Only that single feedback loop consisting of a sample and hold module and an inverter determined whether the system was in a chaotic or (quasi) stable state.

Feedback
After all, such feedback is a rudimentary form of memory. The system can, as it were, remember something from the past. And just like in real life, it can take that into account for the future. This was particularly evident in the transitions between successive tones.

Each time it was brought into chaos from a quasi-stable phase because the driver oscillator was tuned. It took a while before the feedback loop had adjusted the excitation oscillator again in a harmonic periodicity ratio with the lowest resonant mode of the resonator. How that control process works precisely depends on the last pitch and the next desired pitch.

Tweaking a physical modelling synth
If you have tweaked something yourself with this simple physical modeling synth you must have noticed that editing is a completely different experience than with just a feed forward only system. Such as a traditional subtractive setup of oscillator, filter, amplifier, which are controlled by three independent envelope generators. In the latter case, no feedback is active. You control independent signal characteristics as waveform and amplitude.

In the physical modeling synth, however, you control the driving force (the amplitude of the driver oscillator) and the degree of feedback in addition to the pitch of the driver oscillator. In fact, everything was regulated by the 'virtual player' in the form of a LFO. Another aspect that is unmistakably connected to mechanical vibrators is that the exciting force affects the waveform.

The rule of thumb is: the greater the excitation the geater the complexity of the waveform. The LFO output could also be used to influence the waveform of the sawtooth and pulse output of the driver oscillator.

In short: the interesting thing about such a feedback system is that it is highly identity-enhancing. A real thing with peculiarities and insanities. Enough predictable to be able to tweak and play with it. And, enough unpredictable to stay exciting. Well, that seems like real life.

`WorldMusicSynth.pch2`
We will remain loyal to our PLL S&H and Resonator model for the time being. A bit extended with, for example, a Filter Static module, which functions as a simple sound box. But, even better, the instrument has a new player, eMusician. In addition to twelve-tone drunken melodies, he can now also 'improvise in scales. Now the resonator (tube or string) can also be enlarged or shortened.

eMusician consists of an LfoA followed by a so-called KeyQuantize module and behind it a Glide module, also called portamento or integrator. The mode is simply chosen by selecting the desired choice from the seven white and five black keys in the module interface. The Range button determines the pitch span in half tone steps.

You also have a choice of how the incoming (random) values are rounded to the chosen mode: evenly or closest. That speaks for itself: neatly distributed or rounded to the nearest chosen note from the scale.
In addition, there is an extension in the form of two resonance strings, which are only used in variation 6, however.
As a final refinement, the setting options have been extended here and there. Essentially it is still a copy of the virtual string from 'A cyber musician a bow and a string'.

Variations
1 Overtone flute
The synth now simulates an overtones flute. The fact that you now hear a flute is mainly determined by the fact that another input signal is being sent to the resonator: a triangle wave. Why can you wonder.

Let's take a closer look at the basic sound generation in flutes. In all these instrument variants, the sound is created by a directed airflow on a sharp edge. This airflow continues to alternate between above and below the edge. This oscillator type is known as a so-called jet oscillator.

The frequency of the oscillation depends, among other things, on the speed of the air flow. In a flute we see a tube resonator linked to the mouthpiece just discussed. Such a tube resonator has, as we know, its own harmonic resonance frequencies that are determined by the effective tube length.

Imagine a kind of recorder with all finger holes closed. When you play on such an instrument, you notice that when you blow very softly, the lowest tone is produced. This is the lowest resonance mode, also called the fundamental tone. Now, if you slowly increase the breath pressure, you hear the pitch rise slightly, but the system then hesitates and then, as it were, it skips and you hear a tone that is one octave higher, the second harmonic or the air column in the tube is now resonating the second resonance mode. Such flutes really exist: overtone flutes. This variation was inspired by the Norwegian version of the harmonic flute, the seljefløte.

2 Tapping and blowing
In this example, I have not attempted to simulate a specific instrument. The pitches produced by eMusician are sent via the Glide module with a setting time of 4 milliseconds. The values therefore change very abruptly. It comes down to the fact that the effective resonator length is changed very quickly. The onset of the tones is similar to tapping on a string and the percussive with all the valves on your flute. The blown/smooth sounds are created by the (slow) attack of the envelope generator.

3 Echos from Bali, Kecapi plays Pelog
Fortunately, virtuality is much easier to manipulate than reality. In this example, the feedback of resonator to the driver oscillator is switched off, which is of course not possible in mechanical-acoustic reality. In addition, the resonator is made maximum large (lowest pitch: -64).

The string or tube has become so long that they would just call it a Delay at Boss. What we hear is simply a pulse width modulated signal by the output of eMusician. These distinct pulse widths simulate striking a string at different locations. In this case a reference to the Indonesian cither, the kecapi. The mode you hear is an approach of the so-called Indonesian pelog scale (e, f, g, b, c, e).

4. G2 in China
The mainly two types of sounds you hear are a variation on variation 2. The Chinese atmosphere is determined by the enhemitonic pentatonic scale (d, e, g, a, b, d).

5 Japanese dripsody
This example shows another form of pentatonics: with both half and whole tone distances, minor and major thirds: cis, dis, e, gis, ais, cis. The name of this mode is ‘akebono’. This form of pentatonics is called hemitonic; which is very characteristic of traditional Japanese music.

In terms of sound design the same principle as variation 3. Now instead of a pulse wave signal a sine wave with a pinch of glide as a condiment.

6 Mourning in Mumbai

As the title suggests, this preset is an attempt to sketch an Indian atmosphere. What you encounter in many traditional Indian musical instruments is the principle of resonance strings tuned according to the mode in which you play. Indian music always moves in only one key. I used two resonance strings according to tradition tuned on the root and fifth, a replacement of the tanpura. This sitar-like instrument plays continuously this bourdon during the piece of music.

7/8 Fantasy on double bass
These two examples make sounds that are reminiscent of the experimental bowing and plucking of a double bass (variation 7). Why variation 8 is resembling an electric bass guitar is just a coincidence. I deliberately tried to control the system so that it constantly balances between chaos and order. Especially in the chaotic phase you hear all sorts of electronic bleeps and sounds that might come from another source.

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