Vulpus Labs
Swirl

Introduction

Swirl is a polyphonic source-of-chaos which emits two correlated randomly-drifting values per polyphonic channel.

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This can be useful for introducing variance between and movement within voices in a polyphonic synth, for example by patching the first value so that it modulates the pitch of an oscillator, and the second so that it modulates the resonant frequency of a filter.
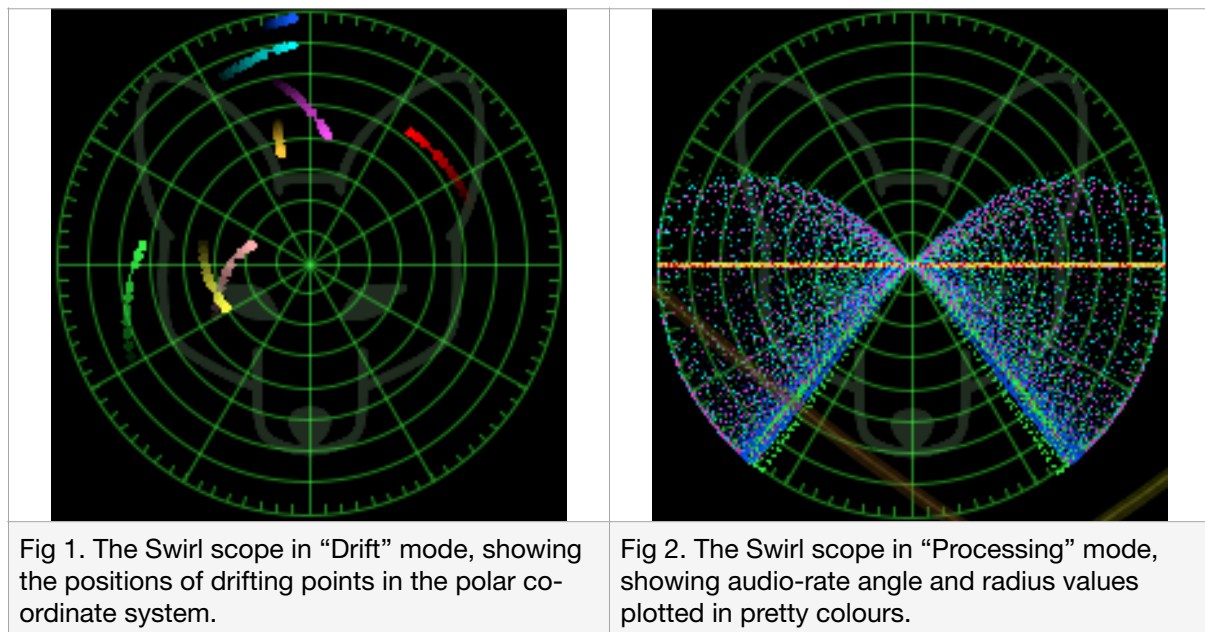
Swirl has a second mode in which it acts as a polyphonic wave-shaper, which combines wave-folding and ring modulation-like effects.

In both modes, Swirl draws pretty multi-coloured plots in its visual scope, showing you what it's doing.

Theory of Operation

Underlying Swirl's two quite different behaviours is a simple function: Swirl converts *polar co-ordinates* (positions expressed as the *angle* of a point anti-clockwise from the positive X-axis, and a *radius*, the distance of that point from the origin) into *Cartesian co-ordinates* (the two-dimensional X/Y co-ordinates of the point).

It's easier to understand what's going on with this if you can visualise it, which is why Swirl displays the polar co-ordinate values it's currently converting in a handy scope (figs 1 & 2):

Fig 1. The Swirl scope in "Drift" mode, showing the positions of drifting points in the polar co-ordinate system.	Fig 2. The Swirl scope in "Processing" mode, showing audio-rate angle and radius values plotted in pretty colours.

In "drift" mode, Swirl emits the X and Y co-ordinates of a set of points in the polar co-ordinate system, and slowly (or quickly - you choose) moves those points around within the polar co-ordinate system until they reach randomly selected targets. If auto-triggering is enabled, each point will seek a new target as soon as it reaches its existing one; otherwise, a manual or CV-controlled trigger can be used to tell all of the points to start seeking new targets at any time (including while they're already in motion).

The points drifting in the polar co-ordinate system "swirl" clockwise or anticlockwise, spiralling in towards the origin or out away from it. Their corresponding X and Y co-ordinate values, expressed as CV signals between -5v and +5v, rise and fall in pleasingly non-linear patterns, slowing as they approach extreme values and speeding up as they move away from them. Their combined amplitude (their Pythagorean distance from the origin) will never exceed 5.0.

"Processing" mode is engaged if a polyphonic input cable is connected to either of Swirl's two polyphonic inputs, "angle" (**θ**) and "radius" (**r**). In "processing" mode, Swirl accepts polyphonic signals from both of these inputs, and converts them into polyphonic output X and Y values.

At 100% "drive", an angle value of +2.5v will point due North on the scope, and a value of -2.5v will point due South, while a value of 0v will point due East. A value of +/-5v will point due West. The radius value received at the same time will determine how far away from the origin the value is plotted.

A switch controls whether the radius value is treated as unipolar or bipolar. If it is unipolar, at -5v a point will lie at the origin, at +5v it will lie on the outermost circle of the plot, and at 0v it will lie on the middle circle. If it is bipolar, then at 0v the point will lie at the origin, at +5v it will lie on the outer circle, and at -5v it will lie on the outer circle in the opposite direction (i.e. North will get inverted to South, etc).

So, for example, given a constant radius input of +5v, and a sine wave LFO oscillating between -5v and +5v supplied to the angle input, the X and Y outputs will look like this (figs 3 & 4):

Fig 3. The X output of a sine wave angle input	Fig 4. The Y output of a sine wave angle input
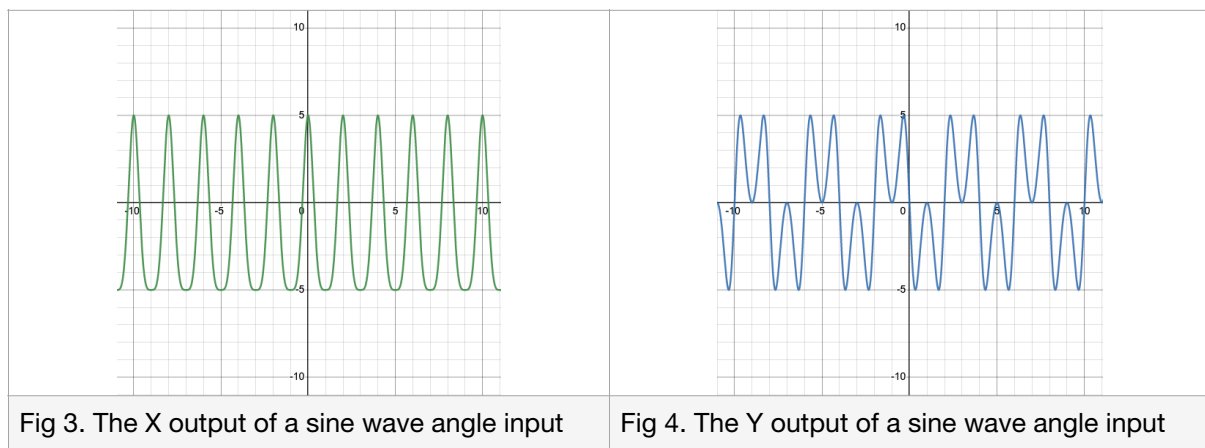
A "drive" function amplifies the angle input, pushing angle values to "wrap around" within the polar co-ordinate system. Pushing up the drive can create more extreme wave shaping distortion.

Variation in the signal sent to the radius input modulates the amplitude of output the X and Y values, and can produce an effect similar to ring modulation if an audio rate signal is used.

By happy coincidence, prettier patterns appearing in the scope tend to correlate to nicer-sounding inputs. Play around with it and see what you can find.

4

Controls

To the left of the visual scope are the input controls for Swirl's "processing" mode.

r in is the polyphonic input for the "radius" value, and θ in is the polyphonic input for the "angle" value. The switch above **r in** toggles between "unipolar" and "bipolar" mode for the radius value.

Below **θ in** is the drive knob, and a monophonic jack which receives a CV input that can be used to modulate the drive amount. The golden dial controls how much the CV signal modulates the drive amount up or down.

Below the visual scope are the controls related to "drive" mode (the default mode, if nothing is connected to **r in** or **θ in**). The **START DRIFT** button manually assigns each point on the scope a new target to drift towards; a trigger signal sent to **TRIGGER DRIFT** will have the same effect.

The **DRIFT LENGTH** knob controls how long it will take each point to reach its assigned target. The toggle switch to its right is a range switch for this knob, allowing you to select between very short and fast movements, and very long and slow ones.

If the **AUTO RETRIG** button is lit, then points will automatically start seeking a new target as soon as they reach their existing one: turn this on for constant motion. The **DESYNC** button introduces some small random variation into the drift length, so that points don't always retrigger at the same time.

In the bottom right hand corner are the two polyphonic output jacks for the **X** and **Y** co-ordinate values of the points plotted in the scope, and a switch which enables DC bias correction for both signals. DC bias correction is

disabled in "drift" mode, because the points are moving so slowly that the circuit recognises the **X** and **Y** co-ordinates as DC signals and eliminates them. You will likely want it switched on in "processing" mode if the plotted points seem mostly to lie in one region of the scope.

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