Audio Effects Portfolio

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April 13, 2016

1 Chorus Effect

1.1 Description

This mono effect combines a track with one or more delayed copies. There is a separate gain control for the dry copy and each of the delayed copies. The delay block accepts fractional delays from a local oscillator (usually at a frequency of 0.1 Hz) where each delayed copy has an LO at a different phase. As a result, the listener will perceive multiple voices or instruments playing together (like a chorus).

1.2 Applications

The chorus effect is an easy way to add depth to a track. In particular, it is an artificial method to simulate double-tracking, a common technique used by artists to create a "fuller" sound.

1.3 Principles of Operation

The chorus effect is composed of several variable delay lines controlled by an LFO. Typically, the original, dry signal is added to the delayed, wet signals. The effect can come in two variants - standard chorus or multi-voice chorus. The standard chorus contains only a single delay line. The multi-voice chorus can contain several delay lines, where each delay line's LFO differs in phase. Figure 1 contains a block diagram for a multi-voice chorus effect with two delay lines.

1.4 Implementation

We implemented a standard chorus (chorus.m) and multi-voice chorus (chorus_multi.m) with four delay lines in MATLAB. The standard chorus had a single delay line with an LFO at 0.08 Hz and peak delay of 30 ms. The multi-voice chorus featured four LFOs that were all operating at 0.08 Hz and peak delay of 30 ms. However, the first LFO was in-phase with the original signal, the second was 45° out of phase, the third was 90° out of phase, and the fourth

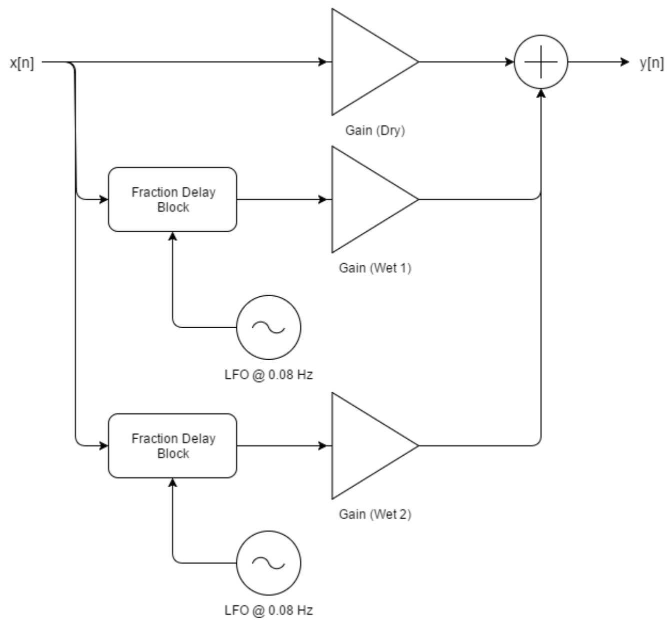

Figure 1: Block Diagram of Chorus Effect

was 135° out of phase. The first and second LFOs were hard panned to the left channel, and the third and fourth LFOs were hard panned to the right channel. The end result is a richer, fuller sound.

1.5 Demo and Discussion

The original audio is an electric guitar track that is mono and panned center. We found the best results were obtained for an LFO frequency of 0.08 Hz and a peak delay of 30 ms. These settings can be heard for both the chorus and the multi-voice chorus effects.

We also examined how the effect changes when parameters are varied. Since the LFO frequency is less than 0.1 Hz, changing the frequency is not as noticeable as an effect like flanger. However, there is a subtle change in the level of depth or richness added by the effect to the track. We created output tracks for LFO frequencies of 0.01 Hz, 0.02 Hz, 0.03 Hz, 0.04 Hz, 0.05 Hz, 0.06 Hz, 0.07 Hz, 0.08 Hz, 0.09 Hz, 0.1 Hz.

Varying the peak delay has a more pronounced effect than varying the LFO frequency. In particular, at a peak delay of 10 ms, the synthetic quality of the flanger effect can be heard. As we vary the peak delay up to 20 ms, the synthetic quality is faintly audible; it is complete gone at 30 ms.

1.6 Further Exploration

To see this effect used in a real world application, check out this YouTube video that uses a chorus pedal on a guitar.

2 Flange Effect

2.1 Description

The flange effect is very popular among musicians, as it adds interest to a track in a periodic way. Flanging sounds as if an original instrument's sound is changed from a natural to artificial and back.

2.2 Applications

The flange effect is often used to add a periodic, synthetic sound to a track. This adds an interesting sound variation to most any musical track.

2.3 Principles of Operation

The flanger is quite simple in concept: it consists of a variable delay which is controlled by a low frequency oscillator (LFO). The delay output is then summed with a non-delayed version and output to the destination.

2.4 Implementation Notes

To implement this effect, we used MATLAB (see Flange.m). Starting with the basic audio file implementation from class to handle importing and playing the audio files. We built upon this and added both a new line in the step function for adding the two signals to be produce together with varying gains. A block diagram can be seen in Figure 2.

2.5 Demo and Discussion

Flanging can be used in a variety of ways to produce a wide range of sound effects from the same track.We adjusted the maximum delay using a 4ms delay and an 8ms delay using a 0.4Hz LFO. We then tried used a 1Hz LFO with a 4ms and an 8ms delay.

The flanging sound is very noticeable, but not extremely deep. Many flangers have feedback in their delay line, creating resonances in the track which can increase the effect's presence in the track.

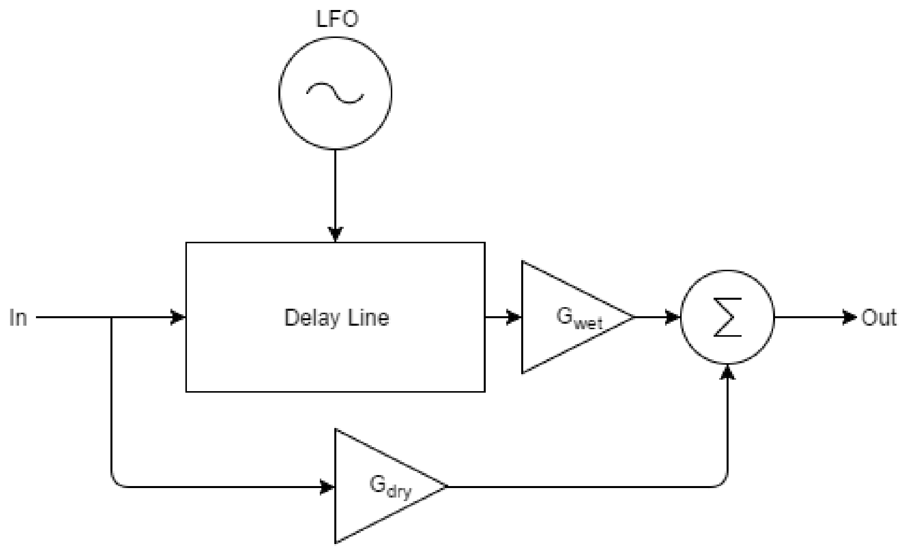

Figure 2: Flange Block Diagram

2.6 Further Exploration

Something to investigate is how this effect would change if it also had a chorus aspects, placing the flange effect at different rates on different chorus channels. This would be an interesting demonstration of two effects from this chapter. A cool way to further investigate this effect is to watch this neat YouTube video about the flange effect here.

3 Ring Modulation

3.1 Description

This mono effect modulates a track with carrier signal to create a wavering robotic sound.

3.2 Applications

Ring modulation can be used to added a robotic sound to a track. Often, it is used on speech or guitar tracks.

3.3 Principles of Operation

Ring modulation is done by modulating the input signal with a carrier signal whose frequency is in the range of the audio. The carrier signal is described by

$$m[n] = 1 - \alpha + \alpha \cos(2\pi f_c n)$$

where α is the depth of the carrier signal and f_c is the carrier frequency. Using $\alpha = 1$, suppressed carrier amplitude modulation is achieved. Decreasing α will add more of the DC term back into the carrier signal. The carrier frequency typically ranges between 10 Hz and 1 kHz. The output is then given by

$$y[n] = x[n]m[n]$$

A block diagram can be seen in Figure 3.

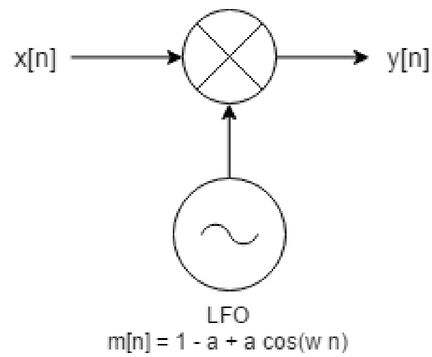

Figure 3: Block Diagram of Chorus Effect

3.4 Implementation

We used MATLAB to implement the ring modulation effect (see ring_modulation.m). An LFO object was used to generate the signal $\alpha \cos(2\pi f_c n)$. This was then used to create the signal $m[n]$. We multiplied the generated carrier signal with the input $x[n]$ to produce the output. Each channel of a stereo track was modulated individually.

3.5 Demo and Discussion

The effect is most obvious when comparing these original vocals to the modulated output (LFO at 250 Hz and $\alpha = 0.5$).

However, a more pleasing use of this effect is achieved when it is applied to this original bass track. To study the effect, the different values of α were tried: 0.1, 0.5, 0.8, 1.0.
Comparing the $\alpha = 0.1$ and $\alpha = 1.0$ tracks, the effect of the depth parameter can be heard. With a larger α, the rich spectrum of the audio is lost, and several notes sound flat.

Additionally, we can vary the frequency of the LFO. Changing the frequency will change the rate of the wavering in the output audio. At higher frequencies, the wavering is occurring so fast that the output audio sounds robotic. We attempt frequencies of 10 Hz, 50 Hz, 100 Hz, 1000 Hz.

3.6 Further Exploration

To learn more about this odd effect, check out this YouTube video.