EmissionControl2 Manual

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EmissionControl2 (EC2) is a new interactive real-time application for granular synthesis and sound file granulation. Features include:

- Granulation of multiple sound files simultaneously
- Multiple simultaneous grain streams
- Synchronous and asynchronous grain emission
- Intermittency control
- Per-grain signal processing (envelope, waveform, amplitude, frequency, spatial position, filter center frequency and resonance)
- Unique filter design optimized for per-grain synthesis
- Matrix modulation control of all granulation parameters with six LFOs
- Real-time display of peak amplitude, grain counter, waveform, scan head and scan range
- Scalable GUI and font size
- MIDI Learn enables mapping to any MIDI continuous controller.
- Code is open source and available at Github

Background

An earlier version of EC was originally written in 2004 and was updated in 2008. It was coded by David Thall as part of his masters project in Media Arts and Technology at UCSB in consultation with Curtis Roads. The program code ran within SuperCollider 3 using a custom library for granulation written in the C++ language. A limitation of this program was that the custom library was compiled for a PowerMac G5 processor only. Apple changed to Intel processors shortly thereafter.

The EC2 project began in early 2019 with an initial goal of rewriting EC to run on modern computers. Over time, EC2 has evolved far beyond the original EC.

Jack Kilgore, a computer science student at UCSB has been the principle coder. Rodney Duplessis, a PhD student in Music and a masters student in Media Arts and Technology made major contributions to the graphical user interface (GUI). As we were concluding

this project, Apple announced a shift from Intel processors to ARM processors before the end of 2020.

Theory

According to a 1946 theory of the physicist Dennis Gabor, any sound can be represented as a combination of elementary sonic grains. The composer Iannis Xenakis was the first to formulate a granular approach to composition. For information about granular synthesis, see the references below.

EC2 takes one or more sound files as input and emits a series of grains. A grain is a segment of sound (a short sound clip), often less than 1/10th of a second (100 milliseconds or ms). In EC2 we allow for longer-duration grains (up to 10 seconds). This provides granular-style processing of short phrases of music or other audio.

The waveform of the file is shown in the Scan Display. The user can set what portion of the file to granulate, whether to scan it forwards or backwards, and how fast to scan through it. Grains will be emitted at the rate set by the Grain Rate parameter.

Any of the Granulation Controls on the top left part of the screen can be modulated using one of the six low frequency oscillators (LFOs) shown in the LFO Controls at the middle right. The Modulation Controls at the top right set the amount of modulation to be applied to the corresponding Granulation Control parameter on the left.

EC2 has a MIDI Learn feature, which makes it easy to map a physical controller such as a MIDI fader box to the Granulation Controls.

Warning

We made a decision to allow extreme ranges for certain parameters. Their interaction creates a vast parameter space. Users should be aware that at extreme settings, the sonic output may be unpredictable, including zones of silence.

Start

To start EmissionControl2, Double-click on the EmissionControl app.

Press the red Engine Start button at the top to commence grain emission.

Synthesis parameters

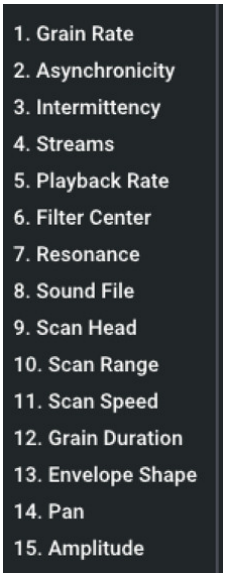

Figure 1.

The fifteen granulation control faders are on the top left side of the console (figure 1).

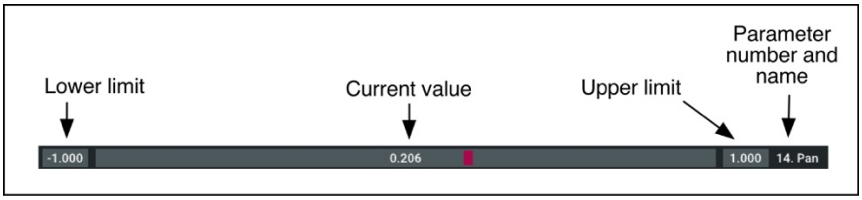

Figure 2.

The default parameter ranges are displayed to the left and right of the fader. Pan, for example, ranges from -1 (left) to +1 (right) (figure 2).

To adjust the ranges, double-click on the lower or upper limit and type. Or click-once-and-drag left and right to set the numerical value of the limit. Shift-click-and-drag accelerates the change.

To stipulate a specific parameter value, control-click on the current value and then type.

MIDI Learn

Any fader can be assigned to a MIDI controller with the MIDI Learn feature.

To learn, perform one of these actions and then move a physical controller knob or fader:

Single button mouse - Hover over a slider and press m
Three-button mouse - Right-click and select MIDI Learn in the drop down menu
Trackpad - Two-finger press on a slider and select MIDI Unlearn in the drop down menu

To unlearn:

Single button mouse - Hover over a slider and press Shift-m

Three-button mouse - Right-click on a slider and select MIDI Unlearn in the drop down menu

Trackpad - Two-finger press on a slider and select MIDI Unlearn in the drop down menu

Granulation Controls

Here is a list of the Granulation Controls with default ranges in square brackets [].

1. Grain Rate [0.1,100] – Rate of grain emission per second

2. Asynchronicity [0,1] – Degree of synchronicity (fader left) versus asynchronicity (fader right) of grain emission. Grain density is the same whether the stream is synchronous or asynchronous. In a perfectly synchronous stream, the grains follow one another at periodic intervals. An asynchronous stream is randomized in time.

3. Intermittency [0,1] – Degree of intermittency of the grain stream, independent of whether the stream is synchronous or asynchronous. Intermittency lowers grain density.

4. Streams [1,12] – Number of parallel streams of grains. Grains from new streams are inserted in between existing grains. Overall grain density is a product of the grain rate and the number of streams.

5. Playback Rate or Pitch Shift [-2,+2] – Shifts the pitch of the grains up or down. Extreme right is highest pitch. Near 0 the sound is pitch-shifted downwards. When less than 0 the sound plays backwards. Extreme left is backwards and pitch-shifted up. When the scan speed (13) is positive, the grains will be played from left to right (i.e., normal playback) but each successive grain will be time reversed (i.e., played backwards).

6. Filter Center [60,5000] – Center frequency in Hertz of a bandpass filter. Each grain is filtered separately.

7. Resonance [0,1] – Sets the Q or resonance of the filter. At a value of 1 it generates a sine wave.

8. Sound File – Selects the soundfile to granulate. Multiple sound files can be loaded. Users can slide the fader to switch between the loaded soundfiles. The file selection can also be modulated by an LFO.

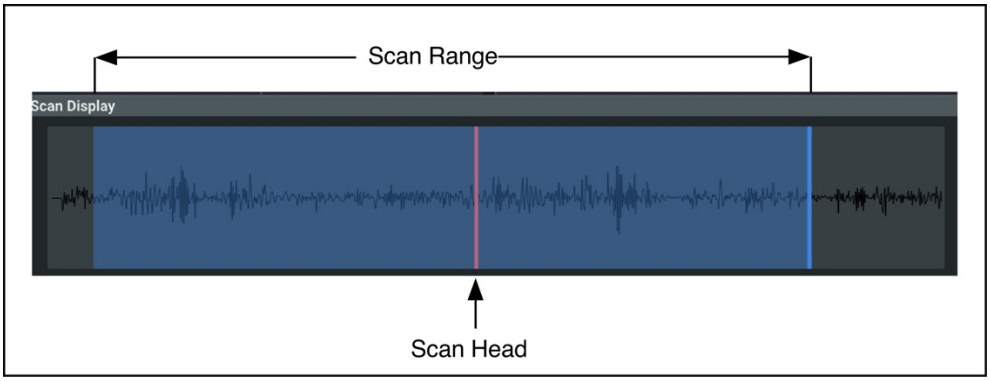

Figure 3.

9. Scan Head– Controls the read pointer: where in the sound buffer to start granulating. The beginning is on the left. The read pointer is a pink vertical line in the Scan Display (figure 3).

10. Scan Range [0,1] - How much of the file to scan. Shown in the Scan Display (figure 3). A value of 1 means scan the entire file.

11. Scan Speed [-2,2] – How fast to scan the file. This is independent of the playback rate, which shifts the pitch of individual grains. The scan speed may be 0, for example, in which case a single grain repeats. The playback rate will determine the pitch shift and/or whether the grain is read forwards or backwards.

12. Grain Duration [0.01, 1000] - Controls the grain duration in milliseconds. The shortest possible grain duration is now dependent on sample rate, or 2000/SampleRate. As an example, if the SampleRate is 44.1 kHz the shortest grain size in ms is 2000/44.1 kHz, which is roughly 0.045 ms. If the sample rate is 96 kHz, the shortest grain size is roughly 0.021 ms.

13. Envelope Shape [0,1] – Determines grain envelope shape. Left = sharp attack, exponential decay (expodec), Middle = bell shaped, Right = reversed expodec.

14. Pan [-1,+1] – Spatial position of the grains. -1 is left.

15. Amplitude [-60,+24] – Adjusts the output amplitude in decibels (dB).

Logarithmic Scaling

Logarithmic scaling for all sliders can be toggled by right-clicking on a parameter and then clicking the item that says "Logarithmic". If no right-click is available, hover over a parameter and press 'l' (as in log). This logarithmic setting applies to your MIDI controller as well.

Granulation Controls Color Design

Parameter types are grouped by color as follows:

BLUE : These concern WHEN grains are emitted
Grain Rate
Asynchronicity
Intermittency
Streams

GREEN : These concern the PITCH Characteristics of grains
Playback Rate (or Pitch Shift)
Filter Center
Resonance

YELLOW : These concern the SOURCE of grains
Sound File

Scan Head
Scan Range
Scan Speed

RED : These concern the AMPLITUDE over time/space envelope
Grain Duration
Envelope Shape
Pan
Amplitude

Modulation Controls

Figure 4. Modulation Controls section.

The Modulation Controls section at top right contains sliders for each of the 15 parameters. The range is 0 (no modulation) to 1 (full modulation). When the modulation is non-zero, the selected LFO (at right) will modulate the corresponding granulator control parameter (at left). As you increase the modulation by dragging the fader right, it begins to have an effect on the corresponding parameter. (The granulator control slider does not move, however.) The source of modulation is indicated by the menu to the left of the fader: LFO1 to LFO6.

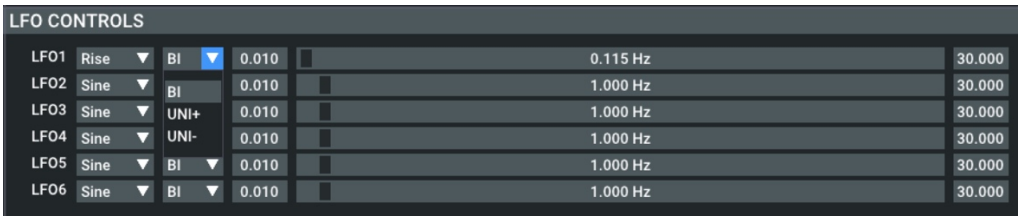

Figure 5. Selection of LFO waveform type.

The LFO Controls section (figure 5) consists of the six low frequency modulation (LFO) controls at top left: LFO1, LFO2, LFO3, and LFO4. Here one can select the type of modulation. Figure 5 shows the linear Rise function chosen. It can be bipolar (BI), unipolar positive (UNI+), or unipolar negative (UNI-).

The LFO waveform options are
Sine
Square
Rise
Fall

Noise (a random sample-and-hold function at the stipulated frequency)

Note that Rise and Fall can also be seen as a sawtooth function.

Presets section

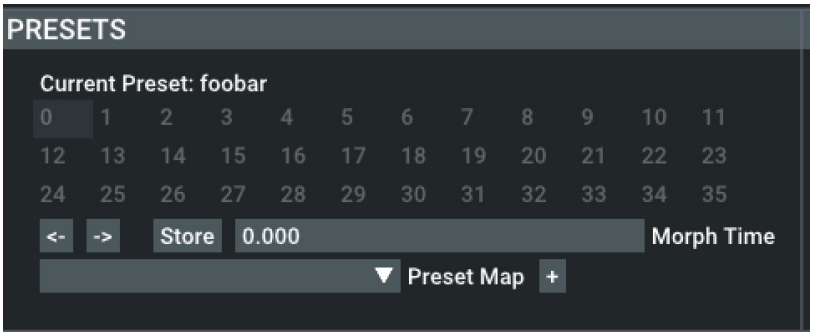

Figure 6. Presets section.

The Presets section lets one save one's settings to a numbered slot (figure 6). There are 240 slots. A bank of 48 are shown. The <- and -> let one select the previous or next bank of presets. Slots can also be named "Store preset as." The name shows up in the "Current preset" header when selected. The Preset Map button creates a new set of 240 slots.

File loading

Figure 7. Audio menu.

To load one's own sample files for granulating, go to the Audio menu at the top left (figure 7). Select Load Sound File to bring in a new file. It will show up in the Sound File slider (parameter 8). To remove a sound file, click on Remove Current Sound File.

Recorder

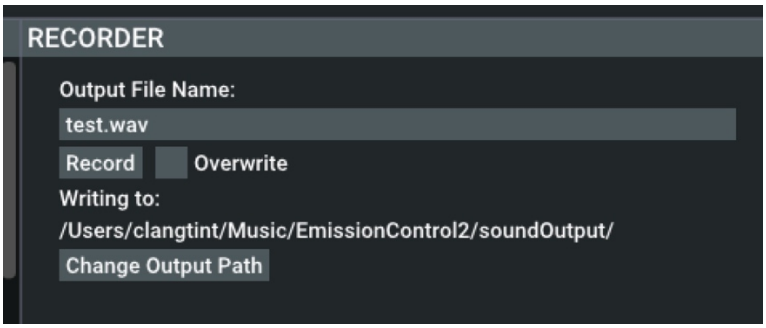

Figure 8. Recorder.

One can record a session using the Recorder function (figure 8) in the middle of the panel. One can name the file.

By default, EC2 sends its output to this directory:

UserDisk/Users/YourName/Music

To change this, for example, to Desktop, select Set Sound Output Folder under the File menu.

Audio Settings

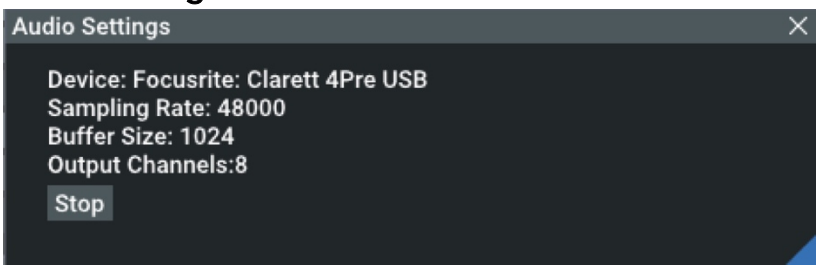

Figure 9. Audio Settings controls while EC2 is running.

One can set the audio output device and sampling rate, etc. under the Audio Settings menu item in the File menu (figure 9). In order to do this you need to Stop the app. Click the Stop button.

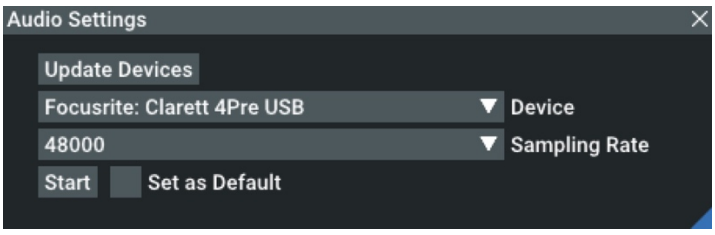

Figure 10. Audio Settings controls.

When the engine is stopped, the Audio Settings menu appears as in figure 10. Here you can make changes.

View

The EC2 panel can be resized by dragging the bottom right corner. It just works!

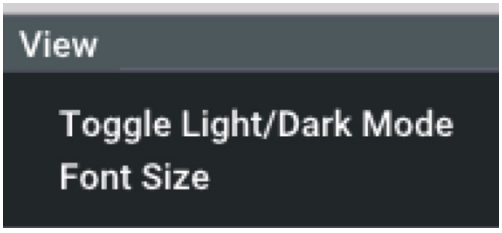

Figure 11. View controls.

The View menu lets the font size be changed independently of the main window size (figure 11). When you select Font Size a convenient fader appears to control size. (Obviously at extreme settings something has to give, but the range of usable sizes is quite variable.)

In the View menu select Light or Dark mode for the GUI color scheme of your choice.

Tip

For pure granular synthesis as per Xenakis's theory, granulate a sine wave sample.

References

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Appendix: Default ranges and absolute ranges

Granulation Controls

Parameter Name	Default Range	Absolute Range
Grain Rate	[0.1 , 100.0]	[0.0 , 500.0]
Asynchronicity	[0.0 , 1.0]	[0.0 , 1.0]
Intermittency	[0.0 , 1.0]	[0.0 , 1.0]
Streams	[1 , 12]	[1 , 20]
Playback Rate	[-2.0 , 2.0]	[-32.0 , 32.0]
Filter Center	[60.0 , 5000.0]	[20.0 , 24,000.0]
Resonance	[0.0 , 1.0]	[0.0 , 1.0]

Sound File	[1st file , last file]	[1st file , last file]
Scan Head	[0.0 , 1.0]	[0.0 , 1.0]
Scan Range	[0.0 , 1.0]	[0.0 , 1.0]
Scan Speed	[-2.0 , 2.0]	[-32.0 , 32.0]
Grain Duration	[2000/SR , 1000.0]	[2000/SR, 10,000.0]
Envelope Shape	[0.0 , 1.0]	[0.0 , 1.0]
Pan	[-1.0 , 1.0]	[-1.0 , 1.0]
Amplitude	[-60.0 , 24.0]	[-180.0 , 48.0]

Modulation Controls	[0.0 , 1.0]	[0.0 , 1.0]
LFO Frequency	[0.01 , 30.0]	[0.001 , 10,000.0]