Vocem:
An Application for Real-Time Granular Synthesis

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Abstract

Vocem is a graphical interface for real-time granular synthesis. It is based on and extends a previous Vocem application by E. Resina running on NeXT. But as where the previous Vocem used CSound and was, in fact, an interface to generate a CSound instrument's score, this version of Vocem implements its own algorithms and tools.

1 Introduction to granular synthesis

Basically, *granular synthesis* technique creates complex acoustic events by combining large quantity of very short sounds (several milliseconds), called *grains*. The grains can be obtained from synthesis or sampling and can have different characteristics like waveform, duration, envelope or frequency. The quantity of grains that takes place within a determinate time interval is called *grain density*.

The theory of granular synthesis dates back to the 1950s and was proposed by the physicist Dennis Gabor. The possibility of working with micro-sounds, in a level beneath the notes, and the consequences that stem from that, soon attracted composers. A few years later Iannis Xenakis suggested the first compositional theory for sound grains.

In the beginning, work with granular synthesis involved strange hardware or complicated procedures like cutting and pasting short sections of tapes. The first experiments in granular synthesis using digital computers were carried out by Curtis Roads in 1975.

2 What is Vocem?

Vocem is a real-time, granular software environment for Windows. The first version of Vocem ran on NeXT. It was basically an interface to generate Csound scores and ran them using a predefined granular synthesis CSound instrument. This new version inherits the philosophy from the old Vocem's graphical interface as well as some of its tools, but it incorporates some interesting new features:

1. Synthesis in real-time.
2. A dual parameter control mode: envelopes vs. sliders.
3. File source grain extraction vs. user defined synthetic grain's waveform.
4. Independent channel control for each parameter.
5. Parametric control via MIDI.
6. Free draw vs. point to point trajectory type of envelope.

3 Why another program of granular synthesis?

In the last few years some good programs for granular synthesis in real-time have appeared for Windows, Power Macintosh or MacOS. And, if working in real-time is not indispensable we will always be able to resort to powerful synthesis environments like CSound or CLM. Then, why another program for granular synthesis? Mainly there are two reasons:

1. Every grain has associated data that determines its characteristics. Besides, a certain (generally large) number of grains will be output every second. For every second of sound we will have a considerable amount of data that we need to precisely control. Obviously, to control all this data individually is not viable, so it becomes essential an implementation of more global controls in order to achieve a high-level granular organization. The question about which should be these few controls and the way they could be used is not solved yet.

   The control variables offered by Vocem allow the user to work with precision on the sound grains and their distribution, without renouncing to do it in a simple and intuitive way. This is due to the characteristics of Vocem's graphical interface and its flexible use.

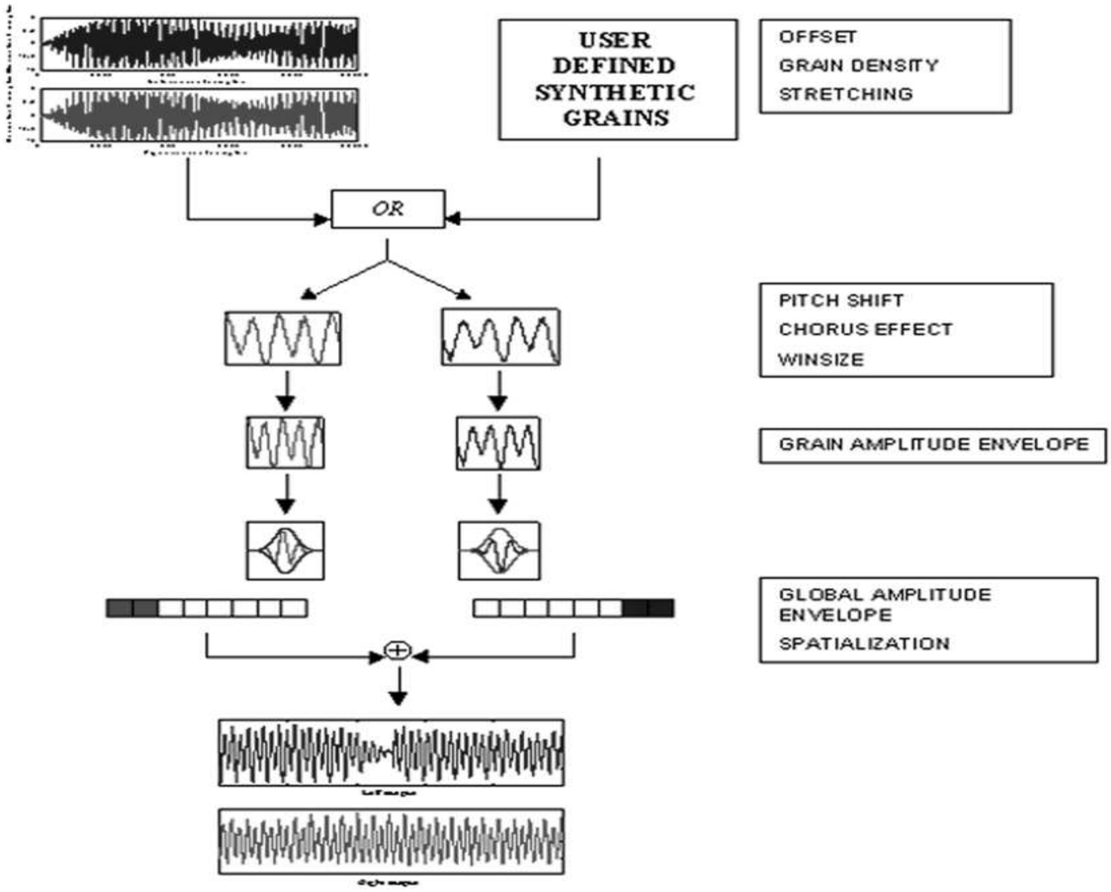

Figure 1. Vocem architecture.

2. Besides control problems, the huge amount of data required for granular synthesis didn't allow to work in real-time in a minimally satisfactory way up to almost present days. Fortunately, faster computers and more powerful software are making this former lack to be gradually overcome.

   Vocem has been created with Visual C++ and Microsoft DirectX, a tool especially designed to develop real-time Windows applications. DirectX own architecture allows Vocem to do a large amount of calculations without renouncing to a high-quality audio output with very short latencies.

4 Vocem description

This section will cover Vocem architecture, parameters and controls.

4.1 Vocem architecture

To use Vocem, we must either load an input sound file, define a synthetic grain waveform or select one of the Vocem's predefined simple waveforms. In input sound source mode, Vocem uses WAV files in mono or stereo format. The program allows the user to work on every channel independently at the same time. Each parameter can act directly on each stereo channel, or on a duplicated single channel if the input is mono as long as an stereo output sound is desired. Grain density, stretch and offset determine the position of the file's grain extraction (the first sample to extract). The chorus effect, the pitch shift and the window size are the next step and determine the last sample in the grain extraction sample count. We then apply an amplitude envelope and we will have our grain of sound ready. Repeating this process, we obtain several grains that we will bring together into a global file sound or send directly to the DAC.

We apply to this sound the global parameters of amplitude and spatialization. Vocem output is 16-bits, either mono or stereo, 22.050 or 44.100 KHz. The process is shown schematically in *Figure 1*.

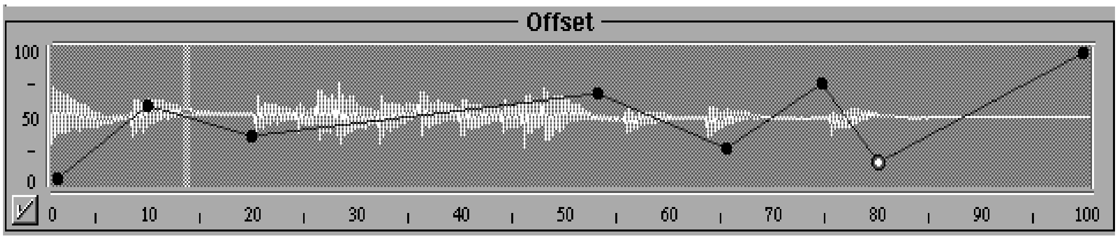

Figure 2. The graphical interface for the offset parameter. The horizontal axis represents time, while the vertical one represents the input sound file position. A value of 0 in the vertical axis means you are reading from the beginning of the sound, and a value of 1 means the grains are being extracted from the end.

4.2 Vocem parameters

Vocem has eight parameters to control the creation and distribution of the grains:

• Waveshaping: when not using the load source file mode, this parameters allows the user to design the grain's waveform or to select one of the predefined simple ones. If the user draws a waveform, a cubic spline algorithm is used to interpolate between the drawn samples. Up to eight different waveforms can be selected to generate a time-evolving grain's waveform which will be the result of interpolating between the selected waveforms and the moment to moment contribution of each one of them to the composed waveform.

• Offset: this parameter determines where you take the grain from within the loaded sound file. The sample ordering of the grains can be reversed if desired, selecting the "reverse grain" option.

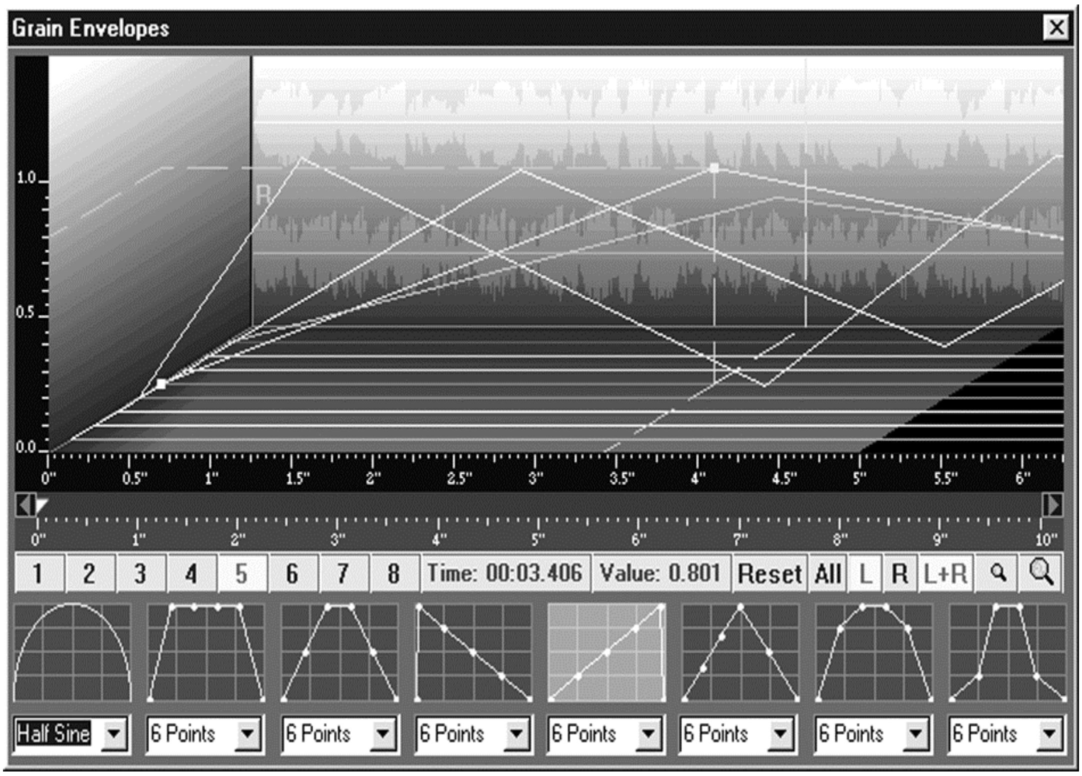

Figure 3. The control window for the grain's amplitude envelope. Vocem allows to define up to eight different grain envelopes. The envolving envelope resulting from the interpolation between the defined envelopes and their respective contribution to the composed one will be applied to the grain. The contribution of the envelopes is independent for each channel.

• Stretch: This parameter modifies the envelopes' time synchronization, determining the advance of the grain extraction position and of the rest of the subsequently applied parameters. In consequence, the length of the output sound will be also altered.

• Density: the number of grains per second.

• Pitch shift: transposes the original pitch of the grain skipping or interpolating samples as needed.

• Chorus effect: this parameter gives the sound segments a range for random detunning. Small amounts create a sort of chorusing effect.

• Winsize: controls the length of the grain.

• Grain amplitude: it is the amplitude envelope for the sound segment. As with the Waveshaping parameter, Vocem allows to define up to 8 grain envelopes and to control their contribution through time interpolating between them.

• Global amplitude envelope: it is the amplitude envelope for the global sound.

• Global spatialization: controls the amount of signal sent to each one of the output sound's channels. Obviously applicable only when stereo output is selected. This parameter is called "spatialization" instead of "panoramics" since next release of Vocem will be using 3D spatialization.

4.3 Vocem controls

In Vocem each parameter can be controlled graphically or via sliders. We can access them by means of the keyboard, the mouse or a MIDI controller. *Figure 2* shows us the graphical interface for the offset parameter and *Figure 3* the control window for the grain's amplitude envelope.

5 Conclusion

Vocem's architecture allows to work with granular synthesis in real-time, with a high-quality audio output and very short latencies. Besides, its parameters and controls permit to control the creation (from a sound file source or from a waveform designed by the user) and distribution of the grains with simplicity and precision.

Next release of Vocem will include 3D sound spatialization, time changing parametric control of sound processing (filtering and reverberation), the possibility of defining algorithmically the parameters evolution (i.e. mathematical functions), and an enhanced MIDI control better suited to live performance demands.

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