A Sound Walk Through Chaos Forest

Program Notes

A Sound Walk Through Chaos Forest is an electroacoustic miniature written for two circle map oscillators. Their parameters are adjusted in real time by the controls of an embedded instrument. As the parameters are adjusted, the performer walks the listener through a forest of chaotic sounds. From time to time during the work, a coupling parameter is increased, causing the two circle map "resonances" to mirror each other's dynamic behavior. This resembles how many objects in a real forest resonate with each other (although on a much slower scale), enabling the energy of life to flow back and forth. At the close of this electroacoustic miniature, the sounds of the two circle map resonances fuse together, creating a composite timbre, whose whole is more than the sum of the parts.

Description

The Circle Map is an exotic kind of oscillator that can exhibit both ordered (e.g. tonal) and deterministically chaotic (e.g. noisy) behavior. One convenient property of the Circle Map is that it will always remain stable even if it is sounding strange.

This musical work explores a web of sounds created through a two (optionally coupled) circle map oscillators, as their parameters are gradually varied at run-time through five mini-joysticks (see below, right) and five potentiometers (see below, left).

Instrument

A circle map unit generator is defined by the following equation, in which Ω controls the base frequency and *K* controls the nonlinear characteristic of the unit generator. In other words, if *K* is zero, then the unit generator produces a sinusoidal output, but if *K* is increased from zero, then it becomes nonlinearly distorted. If *K* is increased further, then it either enters fixed points or tends to behave chaotically. It is an example of deterministic chaos, in which the sound may be deterministic, but it may tend to sound more or less like noise. The state variable is determined by the recursion $x_n = \left(x_{n-1} + \Omega - \frac{K}{2\pi}\sin\left(x_{n-1}\right)\right) \% 2\pi$ and the audio output is determined by $X_n = \sin\left(x_n\right)$.

What is interesting for computer music is the ability to explore the edge of chaos. The circle map unit generator was enhanced for this instrument, to try to widen the edge of chaos. To achieve this (1) the circle map was connected to digital waveguides in order to enable the straightforward synthesis of harmonic tones, and (2) the circle map was coupled to a duplicate circle map circuit. This enables the energy in each of the sections to get passed back and forth to the other oscillator via the K_{crossx} and K_{crossy} parameters. The equations governing the final version of the sound synthesizer are the following:

$$x_n = \left(x_{n-L_1} + \Omega_1 - \frac{K_1}{2\pi}\sin\left(x_{n-L_1}\right) - \frac{K_1'}{2\pi}\sin\left(\left(2x_{n-L_1}\right)\%2\pi\right) - \frac{K_{crossx}}{2\pi}\sin\left(y_{n-L_2}\right)\right) \% 2\pi \text{ and}$$

$$y_n = \left(y_{n-L_2} + \Omega_2 - \frac{K_2}{2\pi}\sin\left(y_{n-L_2}\right) - \frac{K_2'}{2\pi}\sin\left(\left(2y_{n-L_2}\right)\%2\pi\right) - \frac{K_{crossy}}{2\pi}\sin\left(x_{n-L_1}\right)\right) \% 2\pi,$$

where the audio output is determined by $X_n = \sin(x_n)$ and $Y_n = \sin(y_n)$.

Technical requirements

This work is realized using an embedded acoustic instrument that is placed on a table.

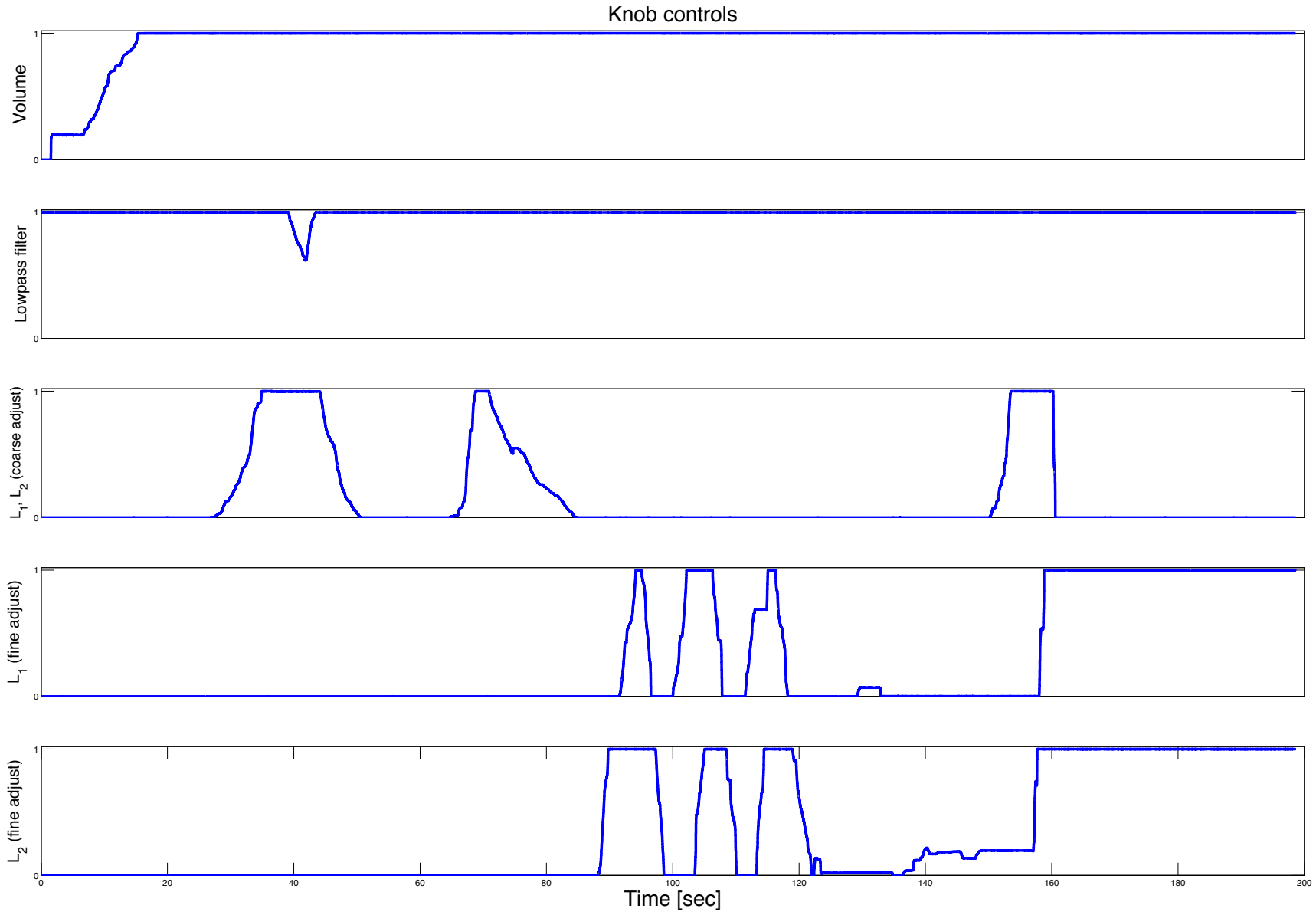
The technical requirements are therefore as follows:

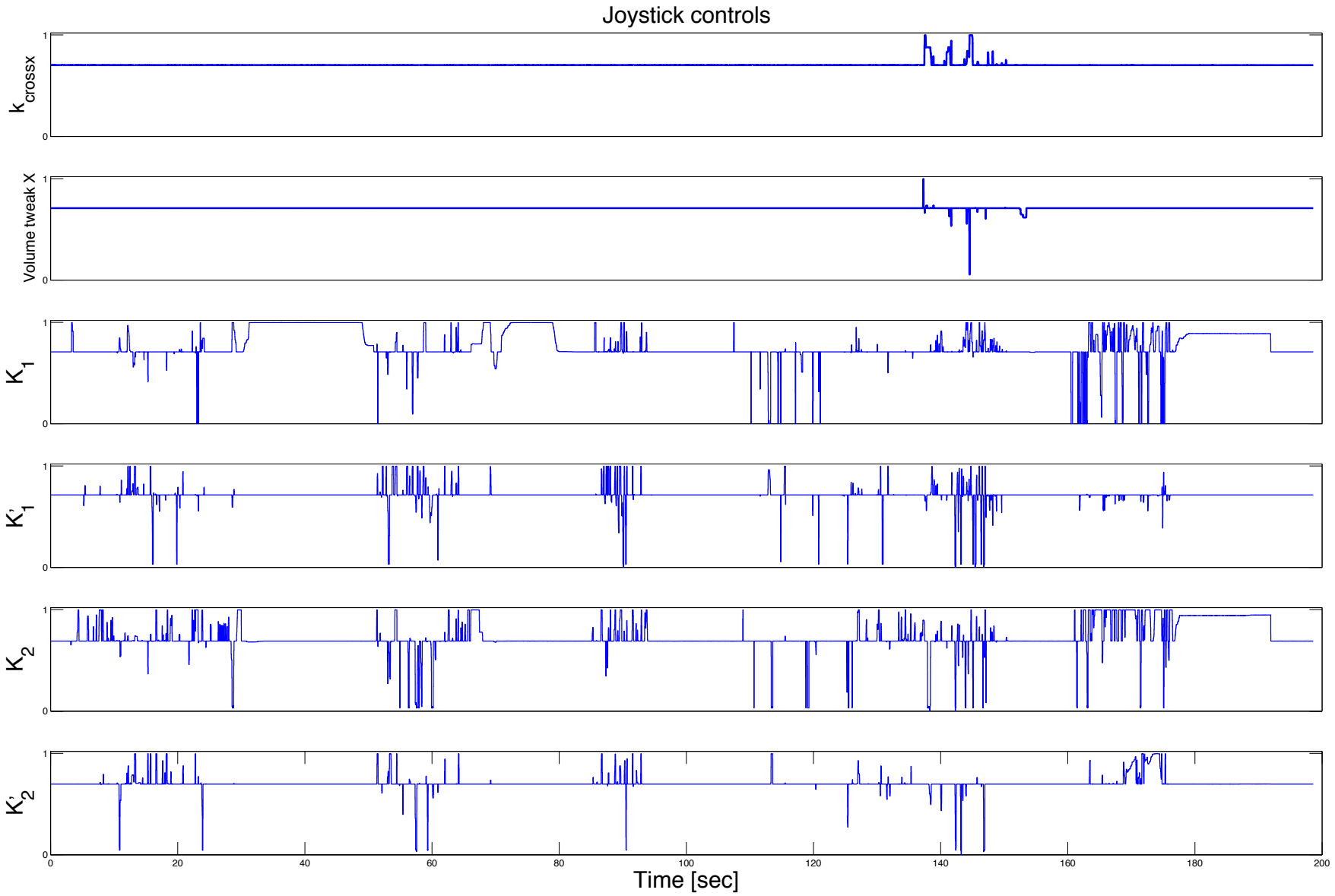
- Half of a utility-sized table's worth of table space
- Chair
- Music stand
- One power connector to 120VAC
- Two directional microphones, each mounted on a boom stand, to capture the sound of the instrument in stereo from a very short distance

The venue should connect the microphones to a mixer to broadcast the sound.

Score

The score is presented on the following pages. Parameters not listed are left at 0 for the duration of *A Sound Walk Through Chaos Forest*.


Knob controls
Volume
Lowpass filter
L1, L2 (coarse adjust)
L1 (fine adjust)
L2 (fine adjust)
0
1
0
20
40
60
80
100
120
140
160
180
200
Time [sec]


Joystick controls
k crossx
Volume tweak X
K 1
K' 1
K 2
K' 2
1
0
0
20
40
60
80
100
120
140
160
180
200
Time [sec]