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21m.380: Music and Technology – Sound Synthesis

Florian Hollerweger

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Dice Rolling Model

There are two main parts of the dice rolling model – the model of the individual sounds and the model of the individual phases. The sounds will be treated first in order to provide clarity when putting those sounds into the phases.

SOUNDS

Sliding

The first sound is that of dice sliding on a table. A physical model can be made up of stick-slip friction on a rough surface with randomly spaced and randomly high peaks. This model creates short quickly spaced bursts of all frequencies that for all intents and purposes is random noise that is low passed with a cutoff that is set by how rough the materials in contact are. In this case, it is easier to look at a spectrogram and note that the cutoff is around 9khz. This noise is further shaped by what modes exist in the dice and in the table, since these modes will be excited in each. Looking at a spectrogram, these are barely visible so the bandpass filters in the noise will have to be toyed with by ear when implementing.

Clink

The next sound is that of one die clinking on another. No such physical model was found for this system; however, it can be assumed that the dice have some sort of vibrational modes. The sound itself is a short, 5-10ms click, of noise filtered from about 4khz to 10khz, as seen by the spectrogram. Further noise shaping can be done in the form of bandpass filters in the noise, since the dice will have vibrational modes. These filters will need to be toyed with by ear when implementing. Going off of the ear, the sound of clinking dice sounds similar to short chirps, or swept sinusoids. A short chirp sweeping from 4khz to 10khz should be experimented with in implementation. Finally, it's important to note that the sound of a clink is dependent on the energy in the collision and how the dice hit each other. It seems safe to assume that this would be too intense to model and instead an approach of taking random clink intensities and filter parameters (such as Q of bandpasses) to account for this factor.

Clunk

The last sound is similar to the clinks except it is the sound of the dice hitting the wooden table. This time, both vibrational modes of the table and of the dice should be taken into account in the form of bandpass filtering the clicks, which again will need to be tuned by ear. Again, this is a short sound except this time it is a little longer, from 10-20 except. In addition, it looks like the sound is low pass filtered at around 10khz, and there is no high pass cutting off the low end. The cutoff frequency seems to shift lower to about 3khz as time goes on. One can hear this sonically, as there is a similar sort of chirp sound except this time it is in the opposite direction, with a sinusoid dropping from 10khz to 3khz.

PHASES

There are three main phases to the model: the pickup, the shake, and the throw.

Pickup

The pickup phase starts with a random start point in the stereo soundscape and a vector for the die to slide towards. A sliding sound is played following this panning scheme and once the vector is complete a clink is generated at that location. If the amount of clinks is less than the amount of dice, the end point is taken as a new start point, a new vector is generated, and the slide clink combo is repeated. The volume of the slide increases with the amount of dice. If the amount of clinks is equal to the amount of dice, the sound moves towards the shaking phase.

Shake

The shake phase is a bunch of clinks of various amplitudes in various spaces of time at an oscillating location in space. A wave somewhere in between a sinusoid and an inverse sawtooth wave that decays over the course of a wavelength will be used to approximate the motion of a shaking hand, since the hand can be thought of as a quick shake and a slower recoil. This waveform will serve multiple purposes. It controls the location of the clinks in the stereo soundscape by controlling the panning. The squared waveform also controls the amplitude envelope of the clinks. The loudest clinks occur at the end of the quick shake and there are smaller clinks at the recoil, making a ca-clink-ca-clink-ca-clink sort of rhythm with clink accented on the downbeat. The squared waveform also controls the spacing of the clinks, considering that when the dice are shaken or recoiled there is more movement in the dice and the clinks are spaced closer together. The waveform itself will be changed to account for different amount of dice. This phase will continue until the user chooses to throw the dice.

Throw

The throw phase consists mainly of clunks with a couple of clinks mixed in sporadically. A physical model of bouncing can be taken an applied to each of the any number of die. As each die moves along, the clunks become quieter and the frequency between clunks increases until there is no more movement. In addition, as it does this movement, the die moves across the soundscape along a given vector form the start point as determined from the shaking motion. This will take the form of an automated panpot. The clinks involved in this step will be approximated by randomly spaced clinks that become more spaced as time goes on. They will go into the same panpots as the clunks will.

This model will be continued to be improved upon as implementation begins and feedback on the model is given.

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