Matěj Mžourek

Popelka – Instruments

1) Grand Piano

The Piano has been creating using mainly additive synthesis techniques [1]. A kind of 2D-interpolation has been used, where the amplitude characteristics were derived from the spectra of the closest two A notes, as I only have the spectra of the A notes across 6 octaves. This means that, for example, the note C3 will have its frequency spectrum interpolated from the spectra of the notes A2 and A3. From each of the A note samples, not one, but two spectral characteristics have been obtained – one from the start of the sound (the initial hammer strike), and one from the "tail" of the note. As time progresses, the used amplitude spectrum slips from the "strike" spectrum (or "pluck" in the code), to the "tail" spectrum, with some additional slight movement of the amplitude of the peaks to make the sound more lively. In the end, the sound was shaped a little using an envelope on the volume, and some reverb was added [2].

2) String Ensemble

The core of the sound is made up of two pairs of slightly detuned square and sawtooth waves spread across two octaves. These waves do not all play at the same volume, as some pleasant balance was found through trial and error. A simple tremolo effect is added to add movement, and a lowpass filter is applied to the sound, as the harmonically rich waveforms tended to sound quite piercing in the high end. An ASR envelope is applied to the volume to add some attack and decay.

3) Flute

The basic waveform is made using additive synthesis [3] with some extra effects utilizing random noise. The noise is affecting the pitch of the sine waves comprising the notes played, which adds some of the typical "blowing wind" effect to the sound. The depth of this modulation is affected by a "slow" sine wave, and, also accented at the start of the sound using an envelope. Some tremolo and an ASR envelope further shape the sound in the end.

4) Bassoon

Done in a very similar way to the flute [3], so only notable differences will be pointed out. The noise FM is much less pronounced with the bassoon, as the "blowing wind" sound is not so pronounced in the bassoon in comparison with the flute. In addition to the typical sine waves used for additive synthesis, sawtooth waves (at much lower volumes than the sine waves) were also added, which reinforces the buzzing sound typical for the instrument.

5) Pizzicato String Ensemble

A Karplus-Strong algorithm, with noise burst excitation and a lowpass filter in the feedback branch of the circuit have been used. Varying the parameters, several plucks of varying timbres were created to simulate the presence of different instruments in the ensemble. Instead of simply summing these plucks into one sound, a randomly large delay (with the upper limit set by a variable) has been applied to each of the created plucks. This simulates that all the ensemble players cannot produce the plucking sound in perfect synchronization. The same reverb [2] as with the Grand Piano is added in the end.

[1] The original audio samples used to obtain the spectra of the sound have been downloaded from http://large.stanford.edu/courses/2007/ph210/otey2/, and are synthesized as well.

[2] The reverb algorithm was demonstrated by our lecturer during the course. The impulse response used was acquired at https://www.voxengo.com/impulses/.

[3] The samples used to obtain the spectra were acquired at our course website, http://sami.fel.cvut.cz/syn/.

The Drum Kit

Note: I have attached the audio file of the drum kit in the required format .m4a, but also in .flac. The .m4a file contains glitches and the audio quality is quite bad. I think it has something to do with the fact that the audio track is in stereo.

1) Kick Drum

A sinewave is pitch shifted rapidly over a small period of time, from a higher frequency to a low one. A volume envelope is applied.

2) Snare Drum

A burst of noise with a short, tuned triangle wave in the beginning.

3) Open and Closed hi-hat

A burst of noise with an applied band pass filter, with a short sound of a pair of saw waves ring modulating each other in the beginning to reinforce the metallic sound. The difference between the open and closed hi-hat sounds is in some of the parameters – different decay time, different frequency spread of the saw waves etc.

4) Rimshot

A burst of noise with a short, tuned sine wave in the beginning.

5) Toms

A combination of a lower pitched sine wave with a longer decay and higher pitched sine wave with a very short decay.

Roland TR-808 audio samples were used as reference to make some of the sounds.