SYNTH CHALLENGE 2021

Musical instrument synthesis

The selected composition is Bohemian Rhapsody. For the alternative composition "Веня Дркин - С соком горького Аира" (Venya Drkin - "S sokom gorkogo Ayra") was selected, midi file for which on DrDom forum (https://vk.com/topic-97803_80551?offset=840 - no author is listed) and extended.

Instrument synthesis techniques

Percussions

To generate the click part of a drum sound the filter synthesis method was used. For drums with noticeable harmonics the additive synthesis approach based on real samples was used. To generate lower frequency noise for bass drums the frequency modulation technique was utilized.

Some sounds required additional touch ups such as a hall effect (some room impulse response files used can be found on [1]), or needed more emphasis on certain frequencies in order to work better in the mix with other instruments.

Electric Guitar & Bass Guitar

The Karplus-Strong algorithm is used to generate the base sound of a plucked string. The string simulation is executed with a high sampling frequency and then sampled down to the general frequency of the track to ensure high quality of the simulation.The later effects such as distortion and reverb are applied to the sampled down simulation output.

There are two different channels containing almost identical electric guitar parts shifted against each other in time. This creates an interesting effect in stereo sound (when played in a midi-player software), however the entire synthesis is calculated in mono so a different way to differentiate between the parts is needed. Different channels have different levels of distortion applied to the guitars. The channel no. 12 also has significantly lower overall volume.

The bass guitar synthesis is identical to the electric guitar, with additional emphasis on the lower frequencies using a low pass filter.

Piano

The base sound of the piano is produced by the Karplus-Strong algorithm that simulates the oscillation of a string inside the piano when hit by a hummer. The base sound is then enriched by adding the reverberations of the piano body (impulse response of a piano taken from [2]) and a base harmonic signal.

String Ensemble & Orchestra Hit

The string ensemble sound is generated from a single violin sound by adding a chorus effect. The base violin sound is generated with the filter synthesis approach using information about the formants of the instrument. The chorus output contains high frequency artifacts caused by the interference of the nearly identical signals, so a low pass filter is applied to the result to produce clean sound.

The orchestra hit instrument is synthesized as a combination of multiple string ensembles (each an octave higher than the previous) and a timpani hit.

Choir

Similar to the string ensemble, the choir instrument is produced by applying a chorus effect on an input signal. The input vocal sound is generated with additive synthesis blended with filter synthesis. A vibrato effect is applied to the later half of the sound. There is a slide effect applied to the beginning of the tone to produce a mode natural vocal sound.

Brass & Woodwinds

Both brass and woodwind instruments are generated similarly to the vocals described earlier. Some frequency ranges are stressed by applying saturation to the output of either high or low pass filter.

References

Reference instrument samples: https://freewavesamples.com/
[1] http://www.cksde.com/p_6_250.htm
[2] http://www.lma.cnrs-mrs.fr/~kronland/IEEE_SAP/sounds.html