Rite of the Earth – composition with frequency-based harmony and ambisonic sound projection.
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Abstract
A multi part composition, called Rite of the Earth will be presented, utilizing the sounds of ceramic instruments built during the Academy of the Sounds of the Earth, a multidisciplinary artistic project held in the Artistic Department of Silesian University in Katowice (Poland). Most of the compositional process and sound synthesis was carried out in SuperCollider, mixing and spatializing in Ardour, with the use of tools by Fons Adriaensen.

Keywords
Sound recording, sound transformation and synthesis, music composition, multichannel spatialization.

1 Academy of Sounds of the Earth

Since 2007 the faculty of Ceramics, in the Institute of Fine Arts, Artistic Department, Silesian University in Katowice has been running a project called "Academy of the Sounds of the Earth", under direction of dr. hab. Małgorzata Skałuba-Krentowicz, exploring the possibilities of constructing non-traditional musical instruments utilizing ceramic techniques. Lecturers and students of the Institute of Fine Arts, Institute of Music and students of Ethnology put their attention on the properties of clay hardened by heat, its acoustic qualities and its sound. The project has been helping in experiencing the idea of creating art on the border between different sorts of artistic and scientific activities. A shared space of artistic language was created in relation to shape and sound in the fields of fine arts and music, enriching the field of research in building a universe of the sounds of ceramic instruments, sound objects and sound sculptures. The achievements of the project have been presented during several exhibitions in the form of concerts at the opening and closing. The present stage is an attempt to bring life to the instruments alone, to allow them to speak for themselves.

Fig. 1. The collection of instruments

2 Preparatory work

Many of the instruments, that were made during the project were built more to be visual objects than musical tools, so they do not meet the criteria that musicians apply to "regular" musical instruments – they are very quiet, play out of tune or are just very difficult to play. However according to the same qualities they seem to be very interesting as sound sources for electronic treatment: after amplification, detuning, retuning, filtering, spatializing and so forth, their sound may become distinctive, unusual or fascinating. The composer's task was to show the natural sound of the instruments and to go beyond using synthesis and transformation techniques.

2.1 Recording of sounds

As the music was from the beginning intended for ambisonic sound projection, most of the recordings were made in 2D B-format ambisonic, with omnidirectional Neumann KM-184 for W signal and two figure-of-eight Røde NT2A for X and Y signals respectively. Additionally some sounds were recorded with a pair of spaced omnidirectional microphones, which in some cases led to better results, as it provided a better sense of spaciousness.

2.2 Selecting the sounds as harmonic models

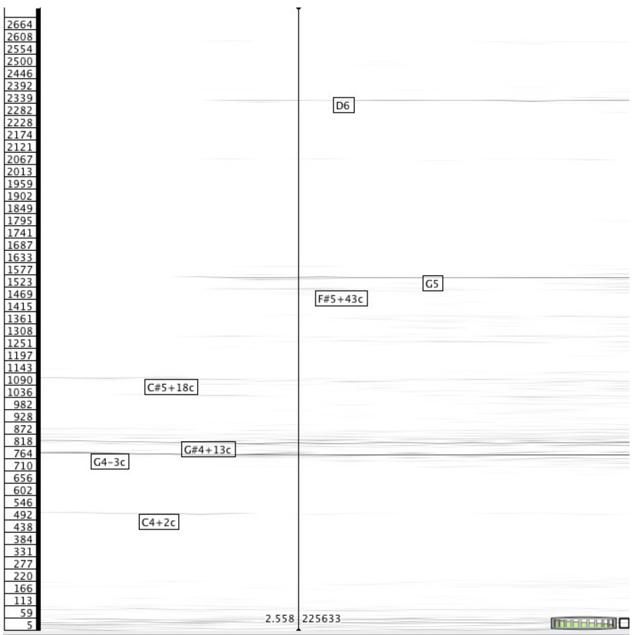

Fig. 2a. Spectrogram of example sound from Sonic Visualiser

After preliminary aural selection, the spectrum of interesting sounds was analyzed. This was done in Sonic Visualiser, which produces spectrograms, which can be tweaked to obtain easy readable results and allows the making of annotations directly onto the spectrogram. These analyses have been mainly used to visually inspect the inner structure of the sounds and to estimate which of the partials might be treated as the pitch base. Many of these sounds were then used as models for the construction of harmony. To import them into Open Music, where most of the musical transformations have been performed, there was the need of a program, that can export the result of the analysis to SDIF format. One of the programs that can do it is Spear [1], [2]. Spear uses a different analysis method (McAulay-Quatieri) and displays the results as sinusoid tracks with time-varying frequencies which can be edited. Unfortunately neither Spear nor OM work on Linux (Spear works under Wine), but both are free software. OM is open source, but relies on LispWorks, a commercial LISP implementation.

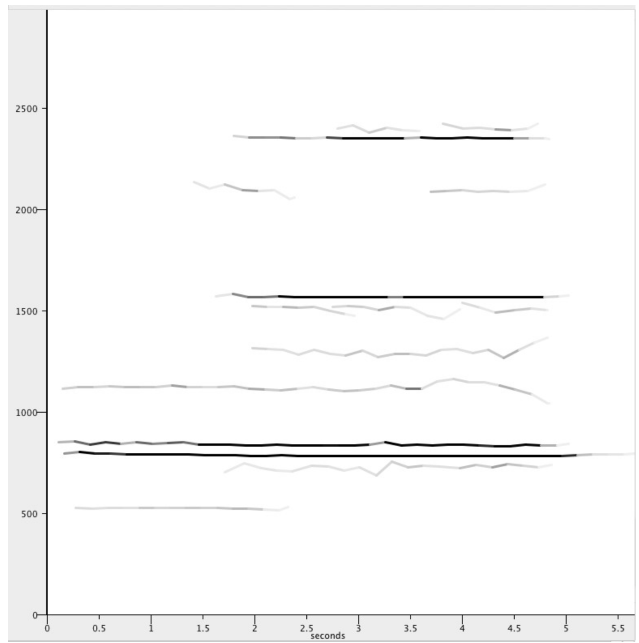

Fig. 2b. The same sound analysed in Spear

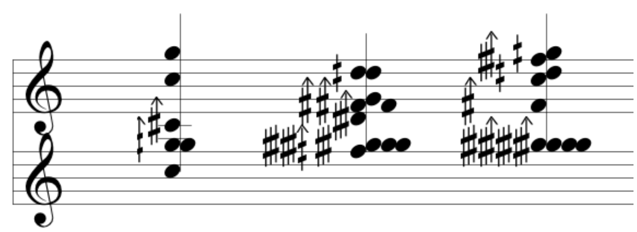

Fig. 2c. Resulting note pitches after SDIF file import in OpenMusic (higher staff is 2 octaves above lower, 1/8-th tone microtonal notation)

The example above (Fig. 2a-c) shows the analyses of the sound of a bowed ceramic bowl (using a violin bow) and the chord progression obtained from Spear/OpenMusic. An interesting aspect of this sound is a (little less than) minor second interval between strong partials.

3 Algorithmic composition sound synthesis and spatialization in SuperCollider

After achieving the desired results in OM the chords were pasted as arrays of frequencies into SuperCollider code. Algorithmic processes evoked here make harmonic (and sonoric) objects of unique authenticity from them .

Composer's Toolkit (Ctk) by Josh Parmenter [3], a SuperCollider library (Quark) for object-oriented composition was chosen as a syntax flavour for compositional and sound synthesis procedures. The class CtkScore stores Ctk events, which may be used in real time or non-real time without any change. That allows easy parameter tweaking and after achieving the desired results the rendering of soundfiles, just by changing `score.play` to `score.write`. CtkControl allows the use of envelopes or even generators in place of parameters.

To preserve the original sounds of ceramic instruments, synthesis techniques, which operate on soundfiles were chosen most frequently – sampling and granular synthesis, but some special or hybrid instruments also appear in this recording.

In Part 2 – "Carillon" to the sounds of chimes (ceramic rods forming a wind-chimes-like instrument) some harmonic FM (with integer ratios) was added to emphasize the pitch of the chimes.

In Part 1 – "Introduction and Mantra", the mantra part was synthesized as a resonant filter with frequency read from an ATS analysis file of a trumpet sound, excited by a shaker sound.

In some flute or trumpet sounds ring modulation or FM modulation has been used to add some artificial harmonics to the sound.

On drum sounds frequency shifting was added to change the pitch without much change in frequency band.

Thanks to AmbPan31 Ugen, by Fernando Lopez-Lezcano the soundfiles have been rendered directly to 3^{rd} order Ambisonic format. 2D ambisonics have been used in this case, so the channels are: w, x, y, u, v, p, q. The "w" signal was modulated to simulate changes of distance and therefore as 8-th channel unmodulated "w" signal was added for feeding it later into reverb.

SuperCollider code was used to synthesize musical gestures as soundfiles, from which then compositions were put together in Ardour.

4 Montage and mixing

Generated soundfiles were then imported into Ardour. During mixing two ambisonic reverbs were added. The first was zitarev1 fed by unmodulated w signal, the second – jconvolver (both by Fons Adriaensen). Zitarev1 is the only reverb known to the author which has ambisonic output. It's a very high quality effect giving a musically desirable result. A specially prepared wxy impulse response was loaded into the jconvolver. This impulse response was made of the chimes clusters panned around the ambisonic soundfield. The result is a frequency dependant reverb, being both a spatial effect and a filter. Both reverbs were fed back into Ardour buses. Complete 2D 3^{rd} order mix might be converted using Ambdec to the desired number of channels.

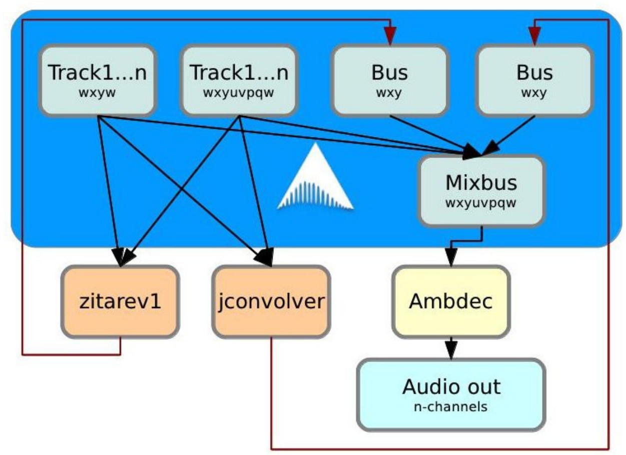

Fig. 4. Signal flow of the final mix

5 Conclusion

A personal achievement in computer music composition, sound design and spatialisation using free and open-source software has been presented. This view is very subjective but shows an example of how a complete system can be utilized. Hopefully this might be an inspiration for other composers and sound artists in search of an environment for their creative needs.

6 Acknowledgements

My thanks go to the originators of the Academy of the Sounds of the Earth, Małgorzata Skałuba-Krentowicz and Katarzyna Handzlik-Bąk, all the people participating in this project, and to all the developers of software I was able to use in the

course of my work on the project.

References

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Software

Sonic Visualiser:
http://www.sonicvisualiser.org/
Spear:
http://www.klingbeil.com/spear/
SuperCollider:
http://supercollider.sourceforge.net/
OpenMusic:
http://repmus.ircam.fr/openmusic/home
Ardour:
http://ardour.org/
jconv, zitarev1, ambdec:
http://kokkinizita.linuxaudio.org/