ATOM TONE v2.0 – software for sonification of atomic data for purpose of electroacoustic music

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ABSTRACT

Atom Tone is the sonification software written in max/msp used for the composition and live performance of electroacoustic music. Its goal is to generate sonic spectrum and textures based and controlled by atomic data. Important part of this project is the exploration of aesthetic qualities of synthesized sounds and then using them in electroacoustic compositions and live electronic music. The sonification method has two parts: synthesis and modulation.

Synthesis uses atomic spectroscopic data as a source for additive synthesis – each oscillator is tuned to recalculated exact light frequency of the atomic emission spectral line. Each element thus creates specific atonal "chord". This spectrum is then modulated with several customable processes. Parameters for these processes are set up only with numbers taken from Mendeleev periodic table of elements.
The aim is to discover musical logic based on the inner proportions and selected properties of the atoms. Part of the project is also building custom interface for controlling this "sonification synthesis". This project is subject of my specific research during my Ph.D. studies at JAMU. The first version was presented at ICAD2016 conference concert. Then it was programmed also during my residency at Institute of Sonology 2017.

For the **klingt gut!** symposium I would like to present this project as ARTWORK in form of live performance where all sounds will be real-time generated with this software tool and controlled with custom interface built for this purpose. If it will be possible I would like to present it also as TECH DEMO where I will explain whole sonification synthesis concept in form of lecture/full paper.

1. INTRODUCTION

In the paper I will present basic concepts of the software + interface. The software is finished and tested during several improvisation concerts (ICAD2016, Discussion concert at Institute of Sonology, NEXT festival etc.). Interface is now in a state of development and will be finished during next few months and ready for the klingt gut! symposium. The first version of the project was presented at ICAD2016 concert at Canberra [1]. Then the software was developed and improved in many ways. At klingt gut! I would like to present the actual state of this research. This wasn't presented yet.

2. SPECTROSCOPIC ATOMIC DATA AS A SOURCE OF FREQUENCIES FOR ADDITIVE SYNTHESIS

Each element gives rich dataset of wavelengths of light emission / absorption spectroscopic lines. I use NIST spectroscopic database [2] as a data source for my further processing and transforming into the sound.

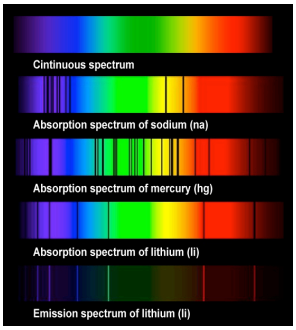

Figure 1 : simple examples of spectroscopic lines http://www.astronoo.com/en/articles/spectroscopy.html

Every element has different number of lines. The parameters of each line that I selected for sonification are wavelength (nm) and relative energy [3]. The calculated frequency of the each emission line controls frequency of one sine oscillator and relative energy controls amplitude (I can select linear or log scaling of the relative energy values, because the range is sometimes very extreme). As the light frequencies are around Thz range I can setup division number for scaling the frequencies into the audible range. This is important parameter for overall feeling of the spectrum and usually during the performance I don't change it to keep global frequency proportions in one setting. I use 32bit float numbers to keep all small frequency mathematical details.

I use two additive synthesizers. First one is limited by number of 35 oscillators where I select only the lines with highest relative energies. The second synthesis use maximally 2000 sine oscillators and creates more complex and close to noise type of sounds. The interesting part is the balance between tonal and noise/stochastic character of the sounds. The special part of synthesis is also the possibilities for stereo or multichannel distribution of the voices (in short: odd/even voices are divided in L/R or more channels - this will be described more in full paper).

3. MENDELEEV AMPLITUDE (and other) MODULATION

Generated pure sound described above can be modified with several processes. The first one I call "Mendeleev amplitude modulation".

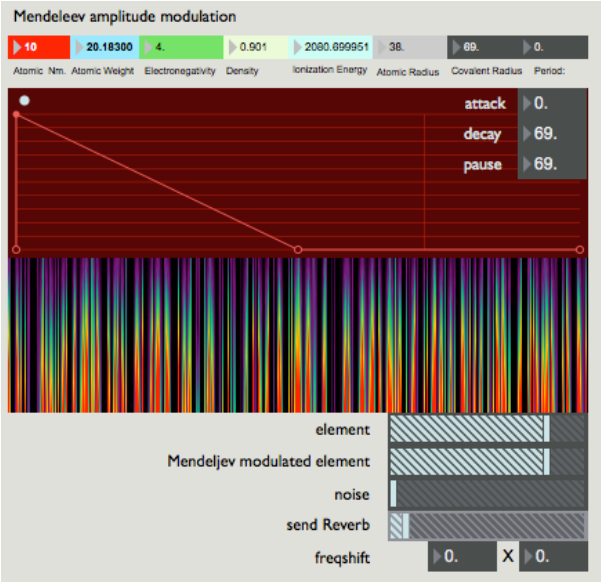

Figure 2: Mendeleev amplitude modulation interface

Parameters for attack, decay and pause are set each time after the envelopes reaches the end. The time values are randomly set up but only with numbers of selected element attributes taken from periodic table of elements (atomic number, atomic weight, electronegativity, density, ionization energy, atomic radius, covalent radius, period). These are numbers used also for all other processing parameters and can be quite freely routed.

Other used processing are multiple frequency shifting, buffering and than modifying with 2d.wave~, fir filtering and waveshaping. This processing is conceptually more open than the exactly described synthesis. The goal of this processing is to find the musically most suitable result and to have many options to play with also with dedicated interface.

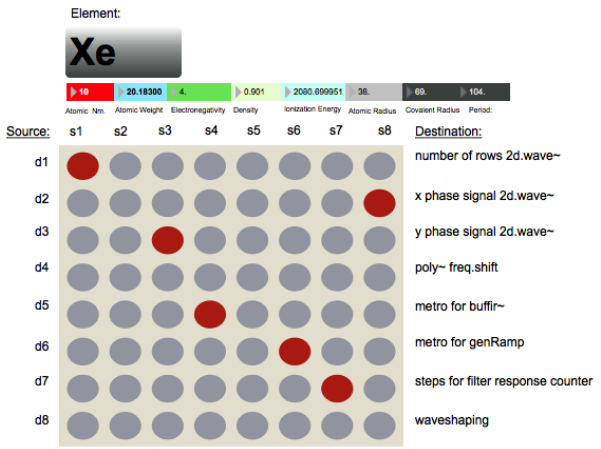

Figure 3: The view of routing matrix in the *Atom Tone* max/msp patch

4. INTERFACE AND PARAMETER CONTROLING

For optimal tactile control during the performance I am building new touch interface based on three touch/pressure strips, knobs and switching button matrix used for setting the routings or selecting prepared presets.

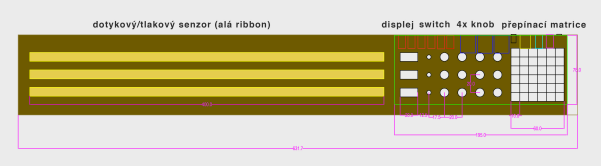

Figure 4: the basic concept if the interface (description in the picture is in Czech)

Every strip is used for selecting and playing one element. Whole periodic table will be divided into three sections - each section for one strip. Performer could play three elements at once and modify the sound with 4 knobs and routing button matrix. Touch pressure will control amplitude of element + intensity of waveshaping.
This conceptually simple solution will bring quick access to all elements, possibility to make smooth transitions or quick changes and have the performativity under finger control. The aim is to don't watch the computer screen during the performance and focus just on playing and finger movements.

5. FICTIVE MOLECUEL SEQUENCER

The latest addition for the software is the Javascript based "fictive molecule sequencer". User can add spheres representing selected element and build their virtual fictive molecule. User can scan their "molecule" in selected axis (X,Y,Z) - manually or automatically. There is also possibility to rotate the molecule in selected axis. The spehere cross-sections controls amplitude of dedicated element. XYZ coordinates can control the filtering, waveshaping and frequency shifting.

I've found this alternative approach of sequencing more conceptually suitable to overall project approach than classical timeline solution. The composition is then more space without beginning or end - the space that can be observed in many subjective ways.

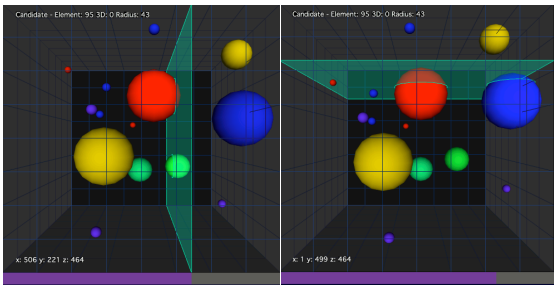

Figure 5: basic view of the virtual molecule GUI

6. CONCERT FORM

Concert lasts around 20 minutes. It is presented in 8 channel speaker setup.

Concert consists from prepared parts (beginning and the end) and improvised parts where I react on the mood of the audience and myself. I play with laptop and described custom interface. Sometimes I played also with video projection and friend who modulate my sound in analog modules (Figure 6), but for **klingt gut! 2018** I prefer the presentation of the pure sound in multichannel setup (which I also did and found it best for the project). I understand the concert as an exploration this specific kind of aesthetic deeply hidden in a matter. That is what interests me the most – the sound hidden inside the matter. I feel something fundamental in this musical approach what keeps me continuing this research. I am trying to bring the artistic experience of the atoms – kind of impersonal reality that is here regardless on us but of course also inside us.

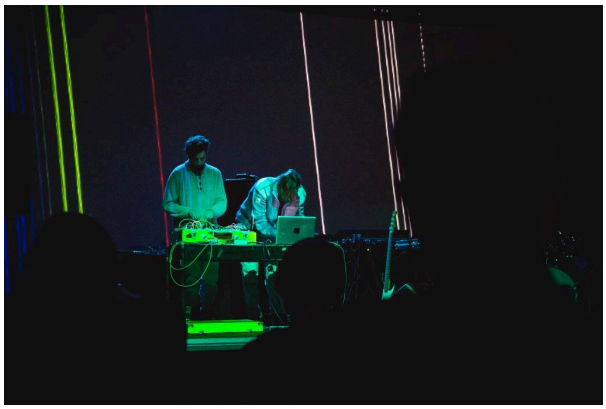

Figure 6: concert of *Atom Tone* at NEXT festival at Bratislava, 2015 [4]

5. TECH-RIDER

Audio:
OUT (from my soundcard): 8x JACK TRS 6,3mm

Space:
8 speakers circle in height 3m of diameter at least 5m - depending on the venue size and amount of expected public
1 subwoofer in the middle of the room
1m high table placed around the center of the room

size of the table approx.: 1.2x0.7m
+ 230V 5x plugs
+ blue soft light on the table from the top
+ darkness + silence

time for setup: 15min
time for soundcheck: 30min

6. MY PERSONAL BACKGROUND AND MOTIVATION

I study Ph.D. (Composition and Theory of Composition) at Janáček Academy of Music and Performing Arts, Brno (JAMU). My Ph.D. thesis is "Sonification used in composition and soun-dart". Also I work as an assistant at Cabinet of Audiovisual Technology at Faculty of Fine Arts Brno University of Technology where I teach Audio Technology and History of Sound-Art. I've done lot of permanent sound installation in public spaces. Many of them are still running (longest one already 9 years). I am creating my own software/hardware solutions for the installations or experimental music performances. I compose experimental/ electroacoustic music and exploring new possibilities with custom build interfaces and software.

7. LINKS WITH ONLINE MEDIA CONTENT

Here are links with the content related to this project:

Audio files (8-channel down-mixed to stereo, mp3, 44.1kHz, 320kbps)
http://www.jiri-suchanek.net/wp-content/uploads/2018/02/ATOM_sonology_DC4_partA.mp3

http://www.jiri-suchanek.net/wp-content/uploads/2018/02/ATOM_sonology_DC4_partB.mp3

Video excerpt from the concert at DNO (Theater at Orlí, Brno)
https://vimeo.com/206698853

Description of the project on my personal web page – including sound examples of elements:
http://www.jiri-suchanek.net/en/project/atom-tone/

Short video documentary from premiere of the *Atom Tone* at NEXT festival:
https://vimeo.com/149558954

My personal web page with my other projects:
http://www.jiri-suchanek.net/en/

8. REFERENCES

[1] http://www.icad.org/icad2016/concert.shtml
[2] http://physics.nist.gov/PhysRefData/ASD/lines_form.html
[3] http://astro.physics.muni.cz/en/
[4] http://2015.nextfestival.sk/atom-tone/?lang=en