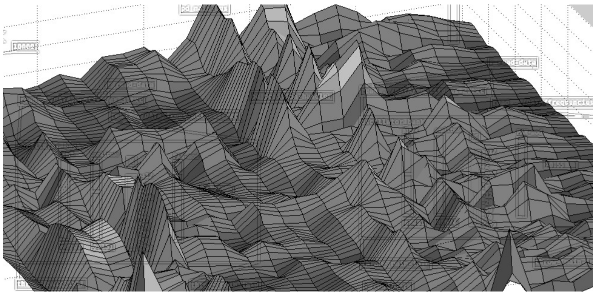
# 'Acid_Hack'

## An Electroacoustic Piece for MEG Data and Live Interaction

Composed:
2017-03-19



Duration:
12:00

## PROVISIONAL VERSION

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## Concept

The composition presented in this paper was realized through the collaboration between neuroscientists and a composer of electronic music. Starting point for the sonification project was a set of Magnetoencephalography (MEG) recordings, which featured samples from a person in normal condition and under the influence of LSD. In an attempt to represent the differences in the state of brain and perception with and without the influence of LSD the composition comprises two parts, connected with an interlude.

Both parts are composed of a synthesis layer, which is driven by the pre-processed MEG data and a layer of processed recording (Smith, 1991), which aims at representing the perceptual domain. Each layer was used to illustrate the change in the perception of a being under the influence of psychedelics, respectively LSD.

In order to achieve an audible difference between the states through sonification of the MEG data, the neuroscientists settled for finding features within the data, which best discriminate between the two states. These are then used to drive an additive synthesis engine, which will be described in the following section. The layer of processed recordings contains rather plain soundscapes during the 'normal part', whereas it uses copious manipulation methods in the 'LSD-part' to create an abstract scenario.

Marking the transition between the two states, the interlude is created from a talk given by Robin Carhart-Harris during the session, heavily processed with granular synthesis.

## Realization

The core of the sound synthesis, the additive model, is built from eight oscillator banks, each featuring 30 oscillators. This amount is sufficient for creating rich harmonic structures. Each bank is configured to contain harmonically coupled partial tones (Levine and Smith, 1998; McAulay and Quatieri, 1986), which are modulated by the MEG data:

$$y(t) = \sum_{n=1}^{N_{part}} \left(a(n,t) + a_{mod}(n,t)\right) \sin(2\pi (n f_0(t) + f_{mod}(n,t))\ t) \qquad (1)$$

The global weighting function $a(n,t)$ is a basic spectral envelope for the harmonics. Different envelopes have been tested and applied, starting from a simple decrease with $a(n) = \frac{1}{n}$ to a parametric modeling of the spectral shape with a piecewise linear model containing two formants. The functions $a_{mod}(n,t)$ represent the time-varying deviations of the amplitudes from the spectral envelopes. They are extracted from the MEG data. Their extent can be specified in the stage of data preparation.

The functions $f_{mod}(n, t)$ represent the deviations of the partial frequencies from the strictly harmonic model. Analogous to the amplitude terms, they are derived from the MEG data in the preparation stage.

For the stereo version, each partial is additionally panned between the two speakers, using a random sequence, in order to enrich the spatial image. The panning strength of all partials can be controlled in real-time with a single control value.

The processed recordings were created with granular synthesis (Roads, 2006) and phase vocoder techniques for time stretching and pitch shifting. Unlike the additive synthesis, this part is not data-driven, but controlled by the performer. Some components were pre-recorded and arranged in the audio sequencer.

All sound synthesis procedures were realized in Pure Data (Puckette, 1997). Several 'qlist' objects managed the sequencing of the partials' amplitudes and frequencies. Ardour was used as underlying audio sequencer and synchronized with Pure Data using Open Sound Control (OSC).
Two MIDI interfaces allowed the live-interaction with the synthesis environment. Several parameters of the oscillator banks were controllable in real-time, accessible through a motorized fader bank.

# References

Levine, Scott N. and Julius O. Smith (1998). "A Sines+Transients+Noise Audio Representation for Data Compression and Time/Pitch Scale Modi cations". In: *Proceedings of the 105th Audio Engineering Society Convention*.

McAulay, R. and T. Quatieri (1986). "Speech analysis/Synthesis based on a sinusoidal representation". In: *Acoustics, Speech and Signal Processing, IEEE Transactions on* 34.4, pp. 744–754.

Puckette, Miller S et al. (1997). "Pure Data." In: *ICMC*.

Roads, Curtis (2006). "The evolution of granular synthesis: an overview of current research". In: *International Symposium on The Creative and Scientific Legacies of Iannis Xenakis. Toronto: University of Guelph.*

Smith, Julius O. (1991). "Viewpoints on the History of Digital Synthesis". In: *Proceedings of the International Computer Music Conference*, pp. 1–10.