Data Sonification with Granular Synthesis

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1 Motivation

What would you expect when one puts together randomly sampled pieces of sound together, noise right? Well that is what we thought as well, however, what you get when we put together these 'grains' is not really noise, but is in fact is some kind of music on its own. This is what is the main idea behind granular synthesis, which can be broadly defined as redistributing and reorganizing 'sound grains' together to form other 'sounds' [1].

2 Granular Synthesis

We have implemented variations of 2 types of synthesizers, **Granulators** and **Glisson**. We have created two independent patches for both of these, which allow for realtime control of the grain parameters. We describe each of these individually below -

1. **Granulation** - We sample different waveforms(sine, square, sawtooth, triangular) whose frequencies have been sampled from different distributions(gaussian, cauchy, triangular, poisson), envelope them with different enveloping functions(hanning, blackman, gaussian, kaiser) and then play them continuously.

2. **Glisson** - Here, we play together 'chunks' of grains where each chunk is defined by a starting and ending frequency, which we sample from different distributions(gaussian, cauchy, triangular, poisson). This gives a feeling of glissandi(continuous sweep of frequency) for each 'chunk' of grains. We then follow the same procedure as above(windowing and playback).

3 Sonification

Wikipedia formally defines sonification as 'use of non-speech audio to convey information or perceptualize data' [2]. What we do is study trends in the data, and map these trends to the parameters discussed above in the sythesizers. By doing this, we hope to 'hear' some sort of trends in the data.

4 System Description

Our Granulator has 4 main parts -

a) Main Control - This sends out the control signals to initialize the following 3 parts.

b) Frequency generator - Samples a frequency from the specified distribution and provided parameters. We have used PD's random(pseudo) number generators.

c) Waveform generator - We generate various waveforms of the specified frequency. For this, we use a patch we had made prevoiusly for on of the labs.

d) Enveloper - To envelope the waveform. We again used PD's envelopers.

For our glisson, the only thing that changes is Part b) i.e. The frequency generator. We generate two numbers which are the start and end frequencies. We then use the line function to generate a uniform frequency sweep across this range, and generate grains of these frequencies.
For the sonification aspect, we perform the data analysis and mapping on python. To pass these parameters to our synthesizers, we use 2 ways -

a. Our Custom Patch - We made a patch to sample and resize an array from a text file into PD.

b. Socket Programming - We open a TCP server on PD, and transmit the parameters to PD via the Client which is in Python.

5 Data Description

We have used a dataset of Epileptic Seizure Recognition [3]. The dataset contains EEG readings for 500 individuals, and also information on whether this person has had a recent epileptic seizure or not. The mapping of these readings and classes with the granular synthesiser parameters are as follows -

1. Mean frequency - We take the magnitude of all the readings and add 50 to it (So we do not have to deal with zero frequency)

2. Distribution - We use Gaussian distribution for individuals who have not had an epileptic seizure and Cauchy distribution for those who have

3. Windowing function - If the particular sample has a positive value the window used is Hanning and if the sample value is negative we use Blackman window

6 Future Work

1. Further work can be done on deriving better mapping functions from the data to the parameters.

2. Work on extracting parameters from music itself(Musical features) and mapping them to the synthesizer parameters to obtain more interesting sounds.

References

[1] Granular Synthesis,
`https://granularsynthesis.com/guide.php`

[2] Sonification on Wikipedia,
`https://en.wikipedia.org/wiki/Sonification`

[3] UCI Machine - Epileptic Seizure Recognition Data Set,
`https://archive.ics.uci.edu/ml/datasets/Epileptic+Seizure+Recognition`