MCT4001 Assignment 4 - Sonification

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Submission date: 2 December 2022

Dataset

Our dataset of choice consists of data collected by the NASA ACE spacecraft between 2003-10-27 and 2003-11-02. We chose this specific one-week time period around the Halloween weekend 2003 because it contains the highest solar wind activity on record. The readings are 5-minute averages over the time period, resulting in 2016 readings.

Our raw data contains 6 data points for each reading, 2 magnetic, 3 physical, and 1 synthetic:

- **Magnetic**
  - **Bz:** the strength of Earth's magnetic field in the north-south direction. Generally we are more likely to see the Aurora Borealis when this value is lower, and especially when it is negative.
  - **Phi angle:** the angle of the interplanetary magnetic field that is being carried out by the solar wind. Rapid changes are often a sign of increased solar wind activity, especially when combined with increased speeds and fluctuations in Bz.
- **Physical**
  - **Temperature (°K):** the temperature of the particles at the measuring satellite
  - **Speed (km/sec):** the speed of the particles at the measuring satellite
  - **Density (/cm3):** the number of protons per cubic cm at the measuring satellite
- **Synthetic**
  - **Kp-index (0-9):** the K-index a measure of the disturbances in the earth's electromagnetic field over a three hour window. The Kp-index is an average of the K-index at 13 satellites positioned around earth.

Audio Corpus

Our audio corpus consists of Dido's White Flag. We chose this song because it was at no. 1 in the charts in Norway during the week of our data.

We split the song in two ways. The first is by simply dividing the song into 2016 individual grains. This results in grains with a length of approximately 110ms. Because the number of grains is equal to the number of readings in the dataset, the entire song is used in the sonification process.

The second is by using the MIDI data to divide the audio into grains of 1/32 notes. This results in fragments which are around 80ms each. This method does also not use the entire song, as each grain is less than 1/2016th of the song.

Mapping Audio to Data

For each grain in both grain types, we calculated the spectral bandwidth, RMS and MFCC coefficient values. By sorting the grains by these values and matching lowest to lowest etc., we mapped spectral bandwidth, RMS and MFCC to density, Bz and temperature respectively. We used grain IDs to store the correct grain for each value of each reading alongside the data.

Sonifying the Data

We sonified the data by iterating through it in chronological order. In each segmentation method, the corresponding grains for each reading were summed and then processed. The filter type and cutoff, playback speed, and playback direction of each compound grain are determined by the Bz, speed and phi angle from the corresponding reading. The processed compound grains are then windowed and appended to the output array.

Finally, convolution reverb is applied to these outputs in segments of 36 grains, with the dry/wet ratio of the reverb mapped to the Kp-index.