Sounds from Swarm

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Part of the scientific process is to examine data. Traditionally, this is done by visual representations through plots and graphs. An alternative perspective can be provided by a *sonification*, i.e. a sonic representation of data. In this project, the *direct audification* method has been applied to Swarm data. A series of digital signal processing techniques are used to output an audible representation of Earth's magnetic field. Sonifications such as these can be matched with visual representation and can potentially enhance the understanding and communication of the data.

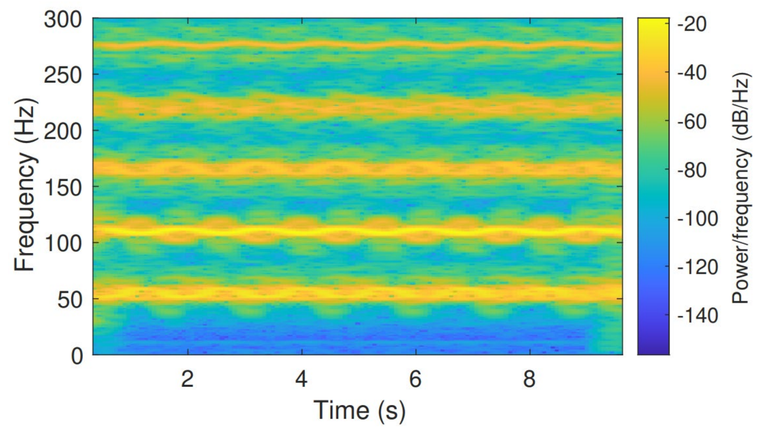


Fig 2 - Spectrogram of a sonification of the magnetic field magnitude as measured by Swarm A from 16-23 Jan 2022

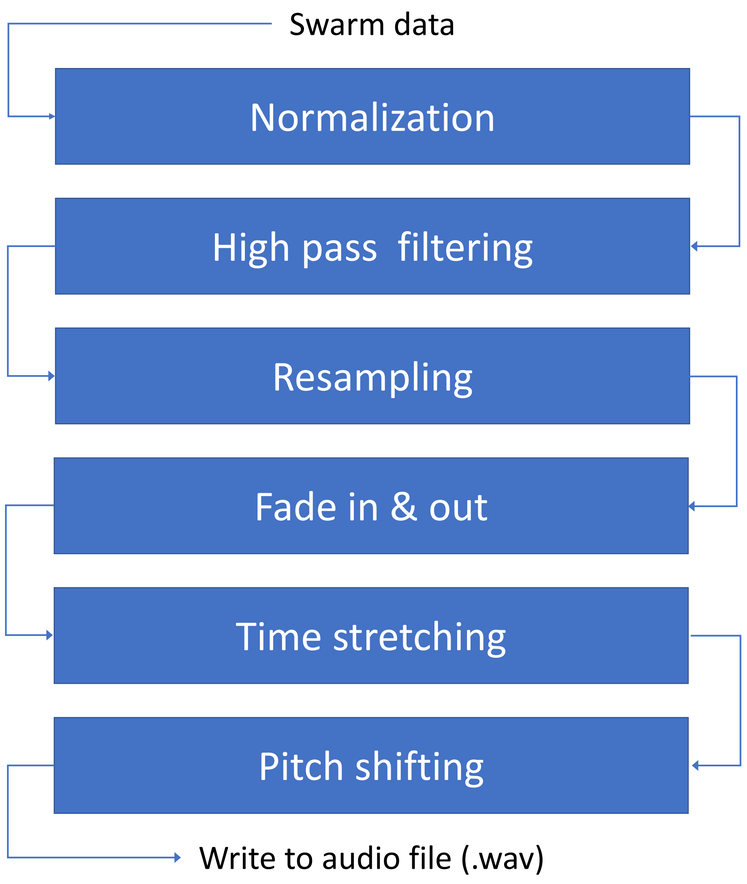


Fig 1 – Digital Signal Processing (DSP) chain

Direct Audification
is the process of taking data points from a measurement and turning them directly into sound by signal processing techniques and is useful when dealing with large time series. A familiar example is the Geiger counter, where a particle or a photon ionizes a gas inside a tube, resulting in a voltage spike that drives a speaker.

When performing direct audification of the geomagnetic data from Swarm, a series of digital signal processing (DSP) techniques are applied in order to transpose the magnetic data into the audible range between 20Hz-20kHz. Figure 1 shows this DSP chain.

Take a listen for yourself
In the headsets below you can hear the sound of four parameters from both Swarm A and B.

Using the controller, you can choose which tracks to listen to and adjust the volume and panning. This way you can create your own mix of data audifications. The data used are the following:

- Magnetic field magnitude (F)
- Field Aligned Currents (FAC)
- Electron Density (Ne)
- Cross-track ion flow

On the two arrow buttons to the left you can switch between a quiet and a stormy week. The time periods for the two data selections are:

- Quiet: 1-7 February 2015
- Stormy: 15-21 March 2015

The python code for generating sounds from Swarm data is freely available on GitLab – follow the link in the QR.

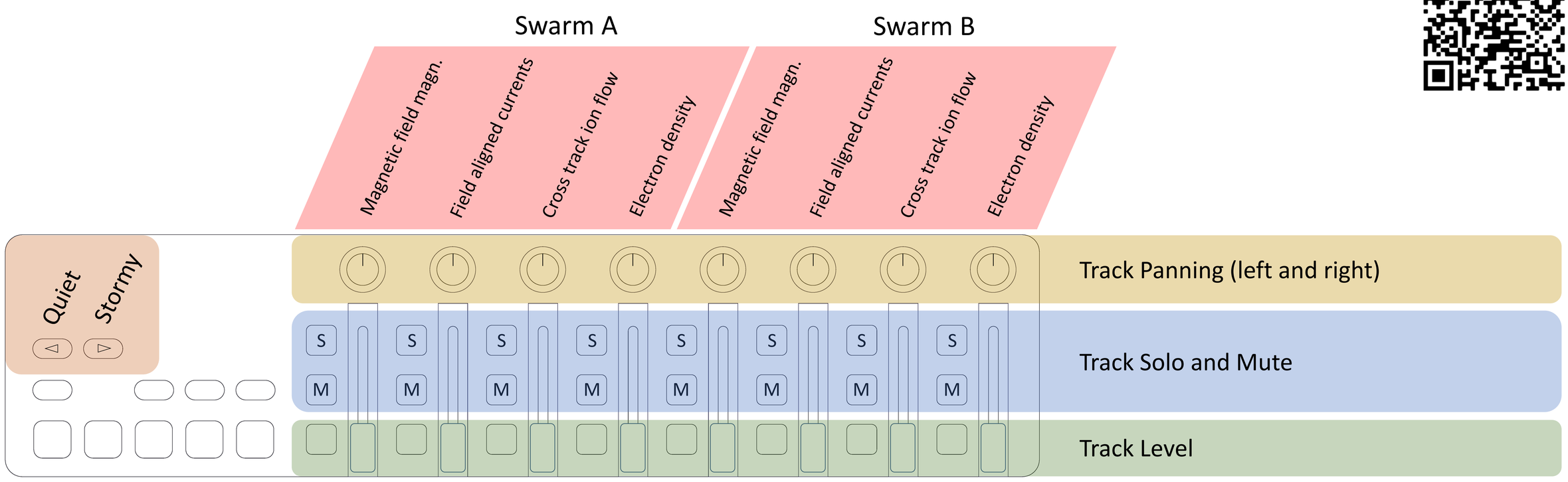


Fig 3 – Controls for the 2 x 8 audio tracks