Mind Your Body
The brain interacts with the body: does it really control???

On the construction of a sonification and audio work, by Roger Dean*, Greg White* and David Worrall (2004)

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The work is based on the data set provided for the International Conference on Auditory Display (Sydney, 2004) competitive submissions. This work was one of ten chosen from the more than 30 submissions for presentation via a 16 channel sound diffusion system during the conference, at the Studio of the Sydney Opera House, and for inclusion on the digital disc representing the chosen works.

Method of Production:
First the appropriate supplied data files (150000 data points, 500Hz sampling rate, corresponding to 5 minutes of acquisition) were given headers so that they could be recognised as 16 bit aiff 44.1kHz audio files. A Python routine was written to do this; the purpose of this was to permit using them as audio files with realtime audio rate reading and manipulation of the data, using MAX/MSP.

Second, the files were audio normalised, providing a very convenient routine to spread the range of values within the files over the whole available bit-depth.

Audio files were then generated as follows:

Audio files 2, 25, 28, 31, 34 and 35 (deriving from the data files of the same numbers) were made by time expansion from the original c. 3secs (150000 samples @ 44100 per sec) up to 5 minutes. This was done with SoundHack's Vocoder function. The resultant sound files were used directly as 6 of the final audio files.

Several MAX/MSP patches were written which 'peek' at the data in the audio files, reading them out in a linear stream which is then available for processing. 10 further audio files were generated using these MAX/MSP processes:
1)Data 1 and 2 were used to control a 'cycle' sound source, and also to ring modulate. This audio file was made as stereo.
2)Data 3 and 7 were used for an FM modulation process.
3)Data 11-15 inclusive were used to control the frequency and bandwidth of a random noise generator. This file was made in stereo.
4)Data 8-10 were used to drive phasor and cycle objects, and the resultant outputs mixed to stereo.
5)Data 11 and 15 (only) were used to compare the original stream with a 'delta' function derived stream (looking at differences between samples over a time window). This was made in stereo.

6)As for 3, but using data 16-18 inclusive, and using different numerical ranges for the frequencies and bandwidths.
7)Data 19 and 23 used respectively to drive a phasor and to control a band-pass filter; audio output made in stereo.
8)Data 27, 29, 30 analysed into pitches for a sampled piano, with frequency of note events also derived from the data stream. Stereo file.
9)Data 34, 35 analysed for 'peaks' which then control sparseness or density of note events played on an electric piano sample.
10)32, 33, 36 analysed to provide pitches for a sampled percussion multi-instrument. A time dependent gradient of activity was superimposed on this.

The (relatively simple) MAX/MSP patches are available for inspection on request, though they remain copyright and IP of the authors.

Data 4-6, 20-22, 24, 26 were not used in the final audio files on the basis of their apparent extreme redundancy in relation to other datasets which were used. 11 and 15 were used twice.

Mixing philosophy: We noted that some of the data streams were primarily related to physiological events (heart beats, respiration, jaw movements), while the majority were electrophysiological data more closely related to neural activity in the brain. Thus we conceived the 'physiological' data (files 27-36) as occupying the 'rear' or 'more distant' part of the final acoustic space (as heard from the centre of the acoustic space). The acoustic space was conceived as slightly more than a hemisphere above floor level. The instrumental sounds were only used for the physiological data, but some audio files were also generated from these data. The 'psychological' data (other files) were conceived as occupying the front or 'closer' part of the space. The psychological data thus occupies the audio space in which detail is best accessed. Furthermore, the mind drives the body, or the body drives the mind: whichever and both.

All the above audio files first were processed for DC-offset removal, then filtered by means of a high-pass (above 20Hz) filter. Some files were equalised, either because they contained certain saturated frequency bands, or to differentiate them from 'neighbours' (those with quite similar data which remained in use). They were then laid out in 15 channel space (the 16th channel was taken up with the subwoofer data derived from all files). They were mixed into 15 separate audio files, each corresponding to what should be projected from the respective speaker, laid out according to the call for submissions, and the then defined capacities of the Studio at the Sydney Opera House (essentially a hemispherical space, in front and behind the majority of listeners). Thus the supplied files are located to an individual speaker, and not to a spatial balance position. The spatial locations of the files correspond roughly to the layout of the sensors generating the data. The data corresponding to breathing is placed roughly in the centre with respect to lateral orientation. The mixing was done (for practical reasons) into three separate and overlapping hemispheres, each corresponding to 5 audio files.

Notes revised by Roger Dean, 2004.06.01

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