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Piano Dreamscapes Ice-Flow Isolation - A case study in binaural mixing for multi-speaker arrays

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Abstract

Piano Dreamscapes Ice-Flow Isolation is the third in an ongoing series of works focused on transformations of piano improvisations done by myself, as well as collaborators Simon Henley & Neusha Taherian. Composed in remote collaboration throughout late 2020 and early 2021, the piece explores concepts of isolation through spatialization, granular synthesis & spectral transformations. I investigate the process of creating a piece that is both fulfilling to listen to in binaural as well as large speaker array systems from home, with minimal hardware and largely spatialized using the free SPARTA software, without compromising on the compositional quality or techniques used. I also outline some novel expansions on existing spatialization techniques such as timbre spatialization which arose during the composition process.

Soundcloud link: https://soundcloud.com/kasey-pocius/piano-dreamscapes-ice-flow-isolation-binaural-24bit

Research Questions & Initial Inspirations

Since 2019, the biannual Montreal New Musics Festival (MNM) has included a concert held at Université du Québec à Montréal's (UQAM) Agora Hydro-Québec hall, showcasing works played through a 32-speaker dome. In 2021, however, the concert moved online due to the pandemic. As a result, pieces were adapted for binaural or stereo presentation, depending on the artist's choice. While limited testing on a smaller 32-speaker dome was possible, most of the composing and mixing had to be done using headphones, as the final premiere would be on headphones.

While the premiere would use the idealized binaural mix for headphones derived from the ambisonic master, I aimed to create a piece that could be enjoyed both through headphones and in a concert hall on a multispeaker system. While composing my previous work Spaces Within (Clark 2020), I used the expensive Spat Revolution Ultimate suite for binaural monitoring & production, rendering an idealized binaural file from the ambisonic master as well as from a mixdown based on the loudspeaker signals. However, I wanted to find more accessible and cost-effective alternatives that could be used within Reaper, while maintaining the quality I achieved with Spat Revolution. The SPARTA (McCormack and Politis 2019) suite met these requirements, being a free and open-source option that is compatible with other ambisonics spatialization tools like ICST (Schacher 2010) and Spat5 (Carpentier, Noisternig, and Warusfel 2015) for MaxMSP.

Artistically, I was interested in expanding my series of pieces "Piano Dreamscapes", which explore spatialization, spectral processing (manipulations of the frequency spectrum) & granular processing (breaking a sound into several smaller elements and manipulating each of those "grains" separately) of piano improvisation done by myself and my colleagues, all stemming from the same text prompt of "falling snow". The previous works explored the themes of spaces and distance by working with self-reliant pianists who could record themselves, previously those in separate cities. However, this time I chose to work with Neusha Taherian who is physically present in the same city, but due to the lockdowns we could not connect in person for the recording process. This spurred the idea of improvisations that interact in some way and move around the space but can never really touch each other.

Artistic Process

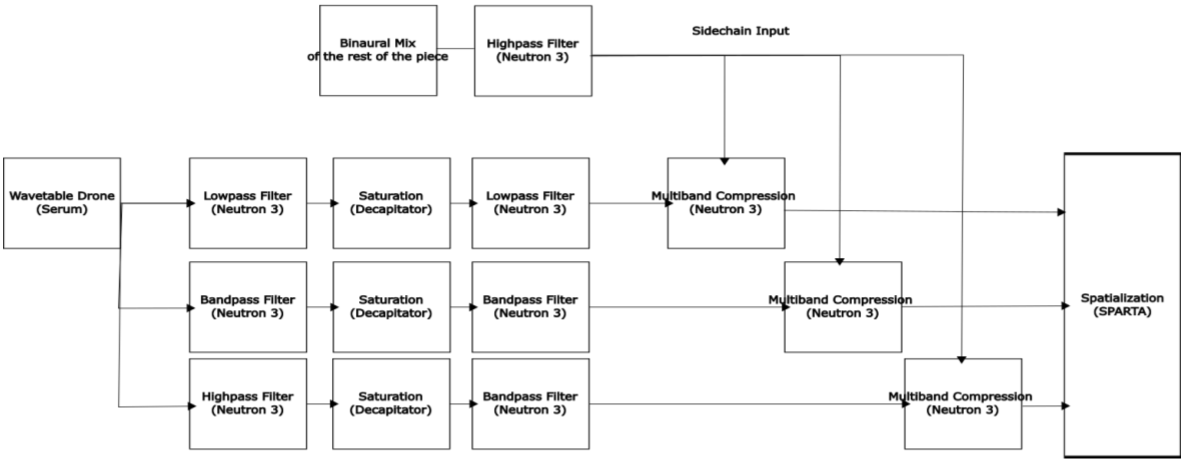

Figure 1: *Block diagram of the processing for the bass layer. Note how a simple stereo patch is split into several frequency bands which are then each processed individually before being spatialized,* ©Kasey Pocius

The piece begins with a wavetable drone, made in Xfer Serum (2014), derived from my initial piano recordings. The wavetable was created from a single piano note and is slowly scanned via a Low-Frequency Oscillator (LFO). A low C1 was played throughout the piece, acting as a foundation for other elements to float above it. Following the techniques outlined by (2009), I split the spectrum with 3 filters made in Izotope's Neutron 3 equalizer. Distortion via Soundtoys Decapitator (2009) was then applied to enhance each frequency band with grit and presence, followed by more filtering in Neutron. Each band was spatialized as a separate stereo source in SPARTA. The lowest frequency band remained stationary, acting as an anchor, while the higher frequency bands rotated throughout the space, adding dimension to the sound. Automation was used to control the level of distortion and frequency range in each band. Additionally, a multi-band compressor, side-chained to a binaural rendering of other compositional elements in Neutron, attenuated specific high frequencies in the subs and created space for other elements.

With the foundation established, I sought a contrasting element to provide structure. An 8-hour recording from a frozen JRF hydrophone (2021) submerged in carbonated water was time-stretched to 6 minutes in Logic Pro X. Using a series of stereo auto-panners (2012) that would randomly pan each time the signal was above a threshold value, the file was given quadraphonic movement after each crack or click. Cecilia5 (Bélanger 2014) was then used to convolve this file with the isolated piano note, generating a repeating but varied note that followed the transient structure and spectrum of the thawing ice. The amplitude envelope of the resulting file controlled the object height in SPARTA, creating the illusion of notes sounding from the top of the space and descending as they decayed.

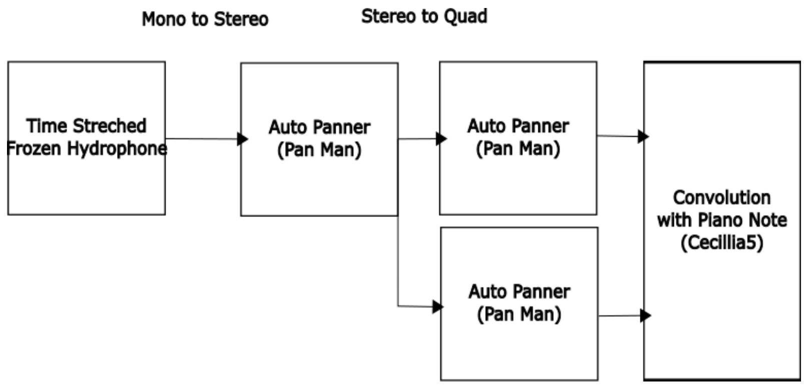

Figure 2: *Block diagram of the mono to Quad process for the Hydrophone material, showing the signal flow of how the mono signal is used to create a series of quadrophonic movements,* ©Kasey Pocius

Neusha's piano improvisation was then loaded into a sampler in VCV Rack (2021), fed into a modulated Comb Filter clocked at 40 BPM. The output of the comb filter is then fed into three granulators modulated by intermodulated LFOs, with one granulator to do traditional granulation, one set as a bank of resonator filters, and the third set to do time stretching via a looping delay. This intermodulation helps to create interrelated movements in the effects, without adding additional clutter. These were then placed as an 8-channel ring above the listener, with further time stretching of the granulated material placed above this ring and below the ear level of the listener.

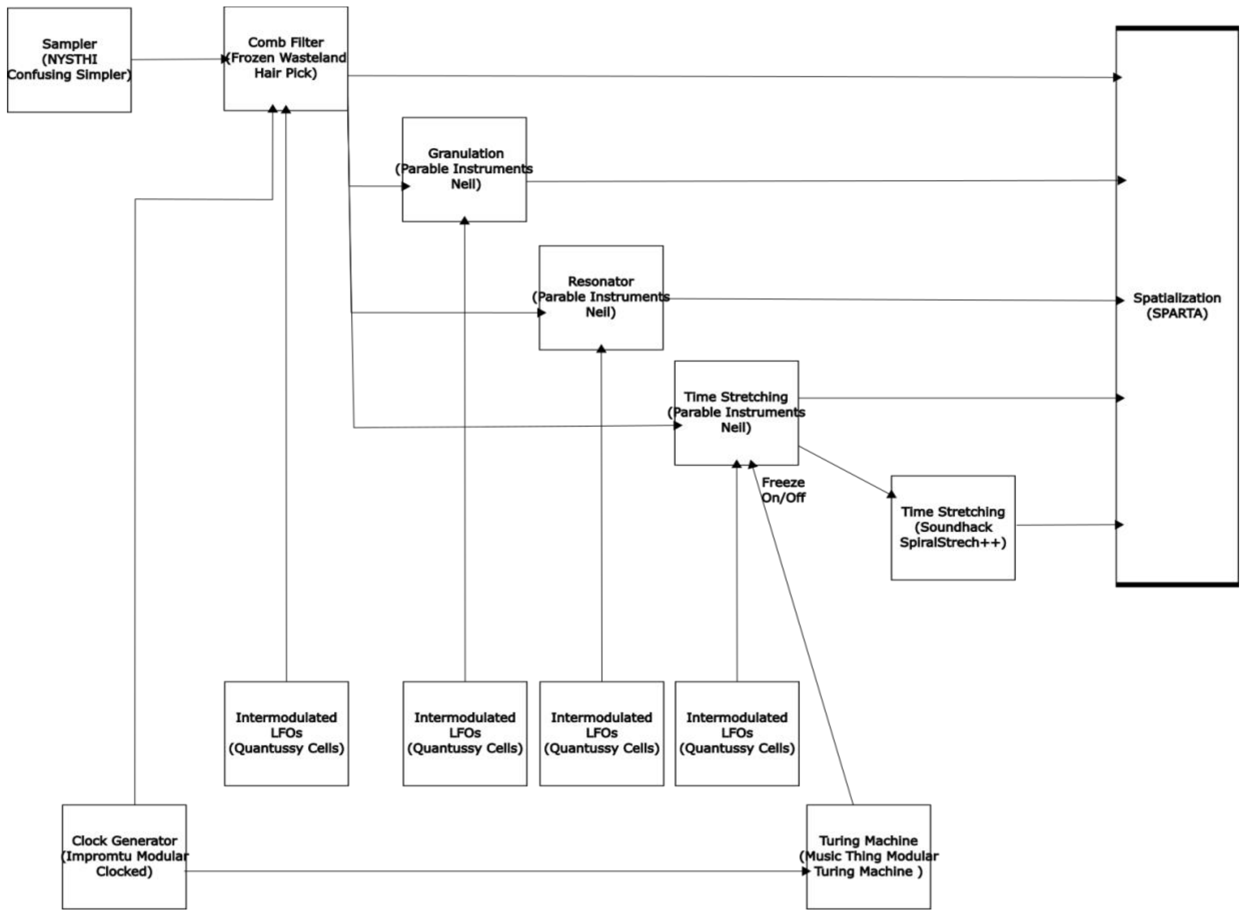

Figure 3: *A simplified block diagram of the VCV processing for the piano improvisations, where a complex LFO system is used to modulate a series of effects,* ©Kasey Pocius

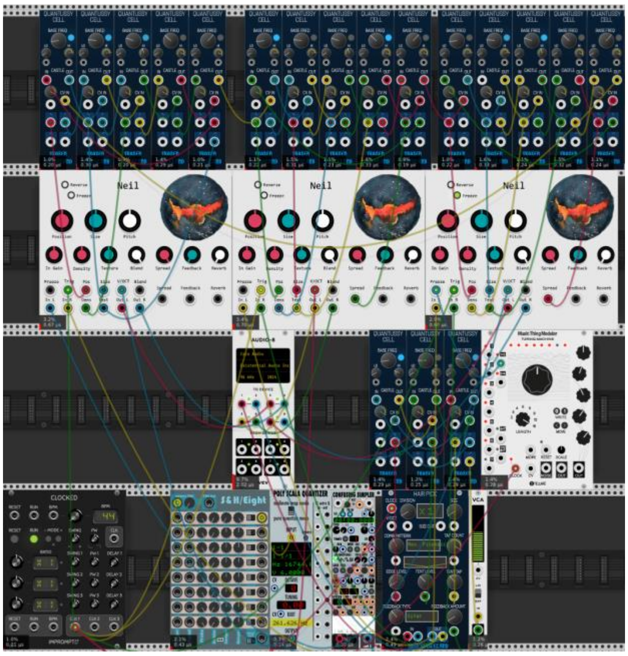

Figure 4: *A screenshot of the VCV processing for the piano improvisations, not the inter-patching of the LFOs that create complex inter-related movements*

I then wanted more dynamic granular material with more timbral variation for contrast. I created a corpus of the previous samples as well as more extreme transformations of these piano improvisations through the use of distortion, filtering, granulation, pitch shifting, and reverberation via Reaktor 6[1] with Twisted Tools Dron-e, Glitchmachines VST Suite (2012), SoundHack (Erbe 1997), Soundtoys5 Effect Rack (2014) and Native Instruments Guitar Rig 6 (2020). This corpus of samples was then fed into Twisted Tools GrainCube, where they were selected randomly for each grain, with up to 8 octaves of random pitch shifting in each grain. Variations of various grain sizes were recorded.

Transitional material was then created through cross-synthesis of existing material. Cross-synthesis involves blending the spectral qualities of two sounds to create a new hybrid texture. I worked with ambisonic audio files in Cecilia5 to inter-modulate spectral characteristics and embedded trajectories of the transformed improvisations to create new hybrid movements and highlight the interaction between algorithms.

[1] https://www.native-instruments.com/en/products/komplete/synths/reaktor-6/

All of these materials were then refined in Reaper, cutting them into clearer gestural elements that highlight the "inner voices" as discussed in (1992) and then spatialized. These materials were placed above the listener to give the impression they are floating "on top" of the sub-bass. The results were then bussed together, and SPARTA's ambisonic rotator tool is employed to shift the whole ambisonic field together, allowing the improvisations to move throughout the space and follow a similar trajectory while never overlapping.

These processed files were also used as a basis for a Sound Particles (Fonseca 2013) session. A torus-shaped grain cloud was created, consisting of many short grains which evolve over a minute to cover the surface of the dome, before its angular velocities are modified such that it becomes unstable and explodes over the sound scene over 30 seconds.

The piano recordings were processed through Izotope's VocalSynth2 to create layers of vocal synthesis that mimicked the spectrum of the piano material. The results were then routed to Max, where they underwent octave filtering using Spat5's filter bank. James Stuart's audio rate AEP patch (James 2015) was then used for audio rate panning of the resulting files. Each band's X and Y coordinates were modulated by a sinusoidal oscillator running at 24 kHz. The phase of these oscillators was then slowly modulated by a third sinusoid, whose frequency was mapped to the Y axis of the accelerometer of a gestural controller, the sopranino T-Stick (Malloch and Wanderley 2007; Nieva et al. 2018). This modulation was recorded for each frequency band, so variations in movements between performances result in slight variations of the spatial image for each frequency band, helping a listener to more easily separate the bands when layered together. Overall, this results in a spatial image that appears to be omnipresent from the audio rate panning but with a clear peak moving through the space from the phase modulation.

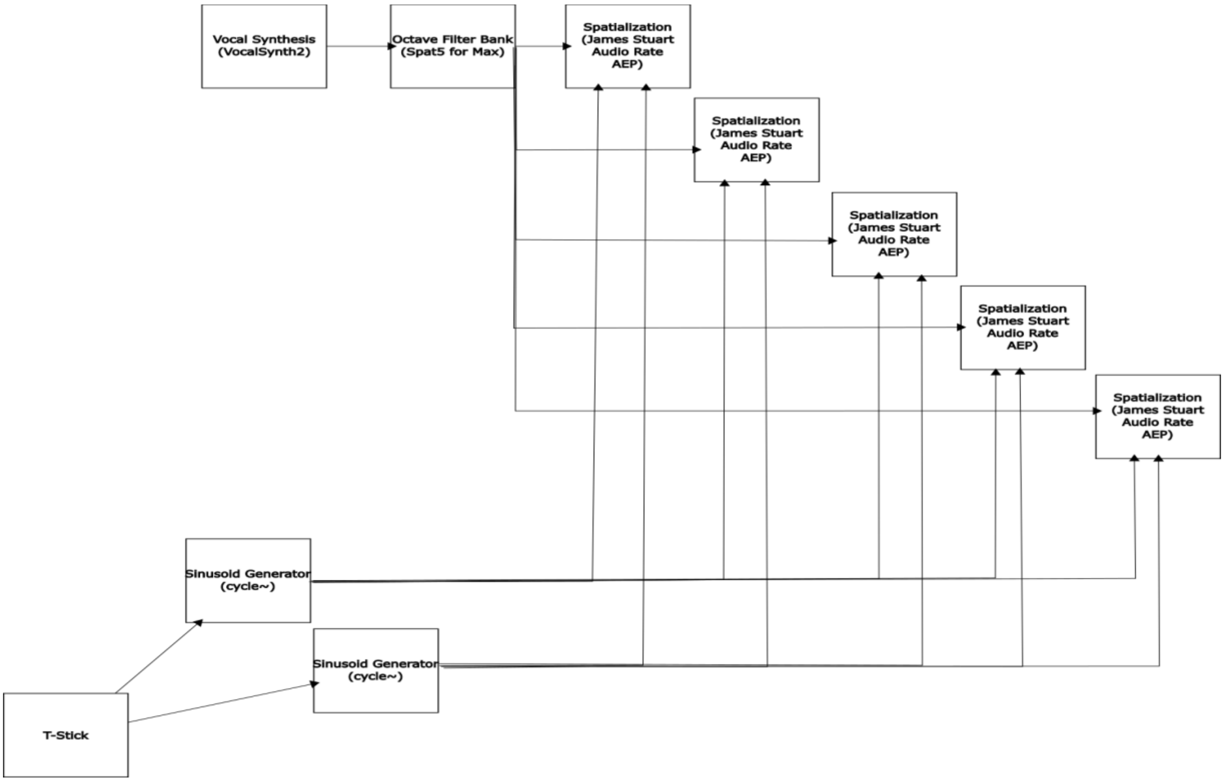

Figure 5: *A screenshot of the Audio Rate AEP Panning patch where a simple recording is split into several bands and spatialized differently through a series of oscillators controlled by a gestural controller, ©Kasey Pocius*

Transportability

During the mixing process of the piece, I had the chance to test the piece on both UQAM's 32-channel dome as well the 26.1 cube setup at Concordia's Visualization Studio. Compared to the binaural render, I found the movements closer to the listener to be more clearly rendered in the cube, while the dome provided better spatial resolution above the listener. The ring of speakers below the listener present in the cube also allowed some elements of the processing on the sub-bass to be more clearly perceived. The Visualization Studio's setup seemed to me to have the highest resolution for movements "inside" of the 3D space of the array.

After the work's initial binaural premiere, it succeeded in my initial goal of being presented elsewhere. The piece was presented at BEAST 2021 (2021), being presented again binaurally. The piece was also part of the Everyday is Spatial conference at UoG (2022), presented on their 22.2 system. Here I found the results similar to those found at Concordia's cube, with the lack of spatial resolution directly above the listeners being unnoticeable due to the denser configuration of speakers around the listener and at ear level than the setup at Concordia.

An 8-channel version of this piece has been prepared for other spaces that do not have height speakers. This has proven to be the most challenging mixdown to complete, as direct ambisonic decoding will contain mostly sub-bass material with much of the high-frequency content being discarded with no height speakers to route them to. The solution which has provided the most fruitful results has been to decode the piece to a series of 3 8-channel rings, which then can be EQed and summed together by hand to maintain more of the frequency spectrum and 2D trajectories.

Influence on future works & Conclusion

The spatialization tool sets & techniques outlined here have continued to be an important part of my works, and only begin to scratch the surface of what is free to artists. While binaural monitoring is no replacement for working in a multi-speaker set-up, the outlined artistic process hopefully highlights that artists can still explore new and novel spatialization techniques which provide satisfying results on both headphones and multi-speaker arrays. This work highlights that high-quality spatial audio can be achieved with accessible, open-source tools, even when working remotely or with minimal equipment.

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