University of Music and Performing Arts Graz (KUG)
Institute of Electronic Music and Acoustics (IEM)

Attractive Correlations

a performance ecosystem

Masters Thesis (Artistic)

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Abstract

This thesis presents the performance ecosystem “Attractive Correlations”. In the emerging field of the ecosystemic framework in music, an overlooked conviction seems to contradict a fundamental principle in this line of creative thought. “Attractive Correlations” propose new directions for dealing with the problematic of the reduced ability of experiencing some of the reciprocal relationships between the involved agencies. The methods that were implemented in the artistic work and investigated in this thesis are: the dissolution of the central stage by the installative articulation of space with various smaller stages and spots, the dynamic alteration of listening modes for the human-agents, the reduced influence of the agency of technocratic determinism via dynamical DSP routines, the extension of the algorithmicity in a perceivable performative domain and the audience conditioning through preparatory events and unconventional concert configurations.

Contents

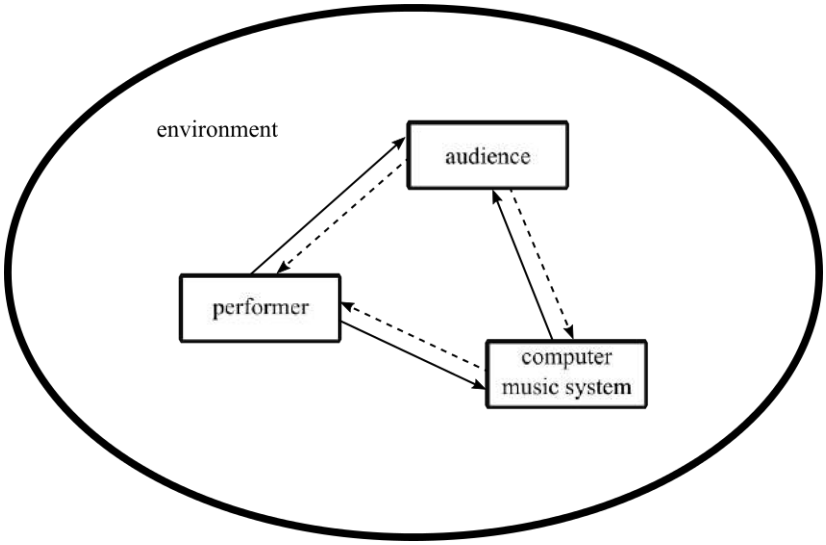
1. Introduction

With the advent of the electronic and digital technologies, a vast variety of new forms for music creation, expression and presentation emerged. A relatively recent field, still trying to establish its niche, organizes the complex web of the music-making agencies under an ecosystemic framework. Described as “interactive music composition” (Impett 2001), “audible ecosystems” (Di Scipio, 2003), “self-organised music” (Blackwell and Young 2004) and “performance ecosystem” (Waters 2007), the framework shares a lot of aesthetic and design principles with other experimental music approaches, such as “open form”, “process music”, “aleatory music”, “free improvisation”, “network music”, “live-electronics”, “sound installation” and “real-time composition and notation”. Its primary source of inspiration is the interdisciplinary field of cybernetics and its more developed branches of system theory, dynamical complex systems, chaos theory and the embodiment movement in artificial intelligence and cognitive sciences.

In this model, *music is understood as a dynamical complex of interacting situated embodied behaviors* (Impett 2001). The nonlinear coupling between the algorithmic and human agents with the environment, produce collective sonic behaviors, which can be characterized as emergent phenomena of the system's dynamics. The composer does not intend the intelligible listening of preconceived music ideas but the experience of dynamic interactions which produce ephemeral sonic structures. The properties of the sound (spectrum, loudness, density) at any instant, contains footprints of present and past activity of the ecosystem. According to Di Scipio (2015): *In sound we auditorily experience at least traces of the power relationships behind the coming into existence of events and their articulation in time and space* …. Di Scipio argues that this view implicitly applies to all musics within the extended socio-historical context. The ecosystemic framework articulates this feature explicitly in the particular context of a performance and it becomes the compositional “material” in the hands of the composer.

The main focus in the ecosystemic community lies in the development of functional coupling relations between the computer music system, the performer and the environment. This center of interest creates often a technocratic sensation by putting the performer in the role of a steersman and the audience in the role of an external observer. This arrangement evokes hierarchical information flow which emphasizes power relationships between the engaged agencies, diminishing the effectiveness of some reciprocal communication channels. It seems to contradict the original vision of carefully planned-out interdependencies (Di Scipio, 2003) where sound is supposed to enlighten social relationships and communicate the systems' dynamics in intelligible and sensuous manner.

In the following figure, the thick lines represent experientially amplified communication channels and the dashed lines attenuated ones. An asymmetry can been seen with the performer holding a powerful active position, the audience a passive powerless one and the computer music system acting more like a mediator of power. This scheme is prevalent in the more conventional “live electronics” compositions which support the hierarchical information flow and understand the computer music system as instrument. The ecosystemic framework has to deemphasize the instrument metaphor and invent explicit mechanisms that experientially amplify the weak connections in order to be in alignment with its theoretical underpinnings.



The experientially amplified and attenuated connections in the ecosystemic framework

As mentioned by Choi (2017): *A challenge still remains in practice, how to convey the dynamics of evolution that can be perceivable through performance realization. … It is a hard problem to simulate, or even to articulate, how the evolving dynamics in a performance in situ actually influence their self-referential function during the performance event among all participating agents, with a cascading self-referential framework from individuals to a performance collective.* "Attractive Correlations" proposes various techniques that aspire to deal with these problems and introduces novel directions in the artistic practice in the field of the performance ecosystem.

2. General description

"Attractive Correlations" explores the immersive music qualities that emerge in a performance ecosystem. The concert hall is transformed into an acoustic arena by a multi-loudspeaker setup, in which instrumentalists, microphonists and audience may move about and interact through the medium of sound. The computer music system dynamically generates mellifluous sonic streams and diffuses the sound of the instrumentalists by means of digital audio networks inspired by neuronal processing. The microphonists react to the sonic activities of the instrumentalists and the audience by approaching them and pointing their microphones towards the sound sources of interest. Sounds from audience members perturb the fragile and delicate equilibria in the generative local sub-networks, while the sounds of the instrumentalists modulate some plasticity parameters of these networks, modifying their generative character. The music emerges from the improvisatory interactions between the human agents, with the instrumentalists and adventurous audience members trying to win the favor of the microphonists and thus gain influence over the sound generation and diffusion of the computer music system.

3. Technical requirements

“Attractive Correlations” is presented in a concert-installation format which can adapt to various venues with variable technical requirements. For a public presentation, a minimum technical setup is required which includes:

- Flat performance area of at least 100 square meters
- 16 full-range loudspeakers (no sub woofer)
- 2 condenser small-diaphragm microphones with super-cardioid polar pattern
- 2 clip instrument microphones
- Wireless audio system with 2 pocket transmitters
- Mixer which supports 16 outputs and 4 inputs
- Audio interface that supports 16 outputs and 4 inputs
- Computer with a quad-core processor, 2.5 GHz clock-speed, 4 GB RAM memory.
- Linux operating system, Pure Data (Vanilla version 0.47.1), iem_tab library, JACK Audio Connection Kit
- 20-40 Chairs, 2-4 small tables or stands
- 2 spotlights

This minimum setup applies for a performance with 2 microphonists and 2 instrumentalists. The 16 loudspeakers are divided into the “sky” and 2 “islands”. The “sky” is consisted of 8 elevated speakers (more than 3.5 meter) and can have variable heights and directions. An “island” requires a hanging microphone (reaching 5 cm distance from floor) with a spot light and 4 circularly positioned loudspeakers (up to 2 meters height) directed to the microphone.

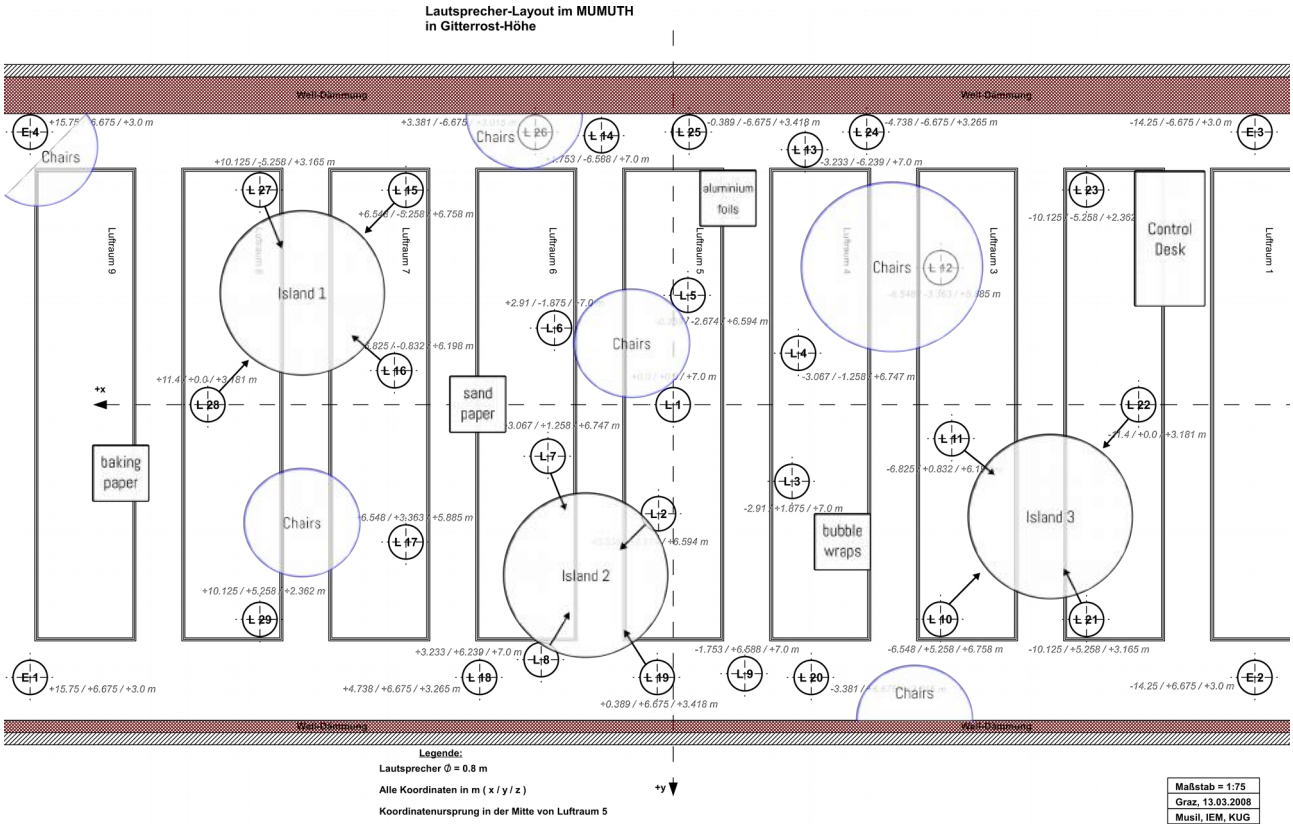
The concert installation can be extended with more loudspeakers for the “sky”, more “islands” with microphonists and more instrumentalists. An additional “island” with a microphonist would require 4 more loudspeakers, 1 more microphone and spotlight. An additional instrumentalist would require 1 more clip instrument microphone and 1 more pocket transmitter. These three ways of expansion are not interdepended and there could be combinations of e.g. 2 instrumentalist, 2 “island” and a “sky” with 32 speakers or 5 instrumentalists, 2 “island” and a “sky” with 8 speakers or 2 instrumentalist, 4 “island” and a “sky” with 16 speakers. All these extensions should be supported by appropriate mixer, audio interface, computer and wireless audio system.

An “island” with a microphonist.

4. Space articulation

The loudspeakers of the “sky” as well as the “islands” are positioned in a way that cover all the performance area and if possible not by forming any perfect shapes or symmetries. The chairs are positioned in circular or semicircular arrangements, facing the exterior of the circle. The tables-stands with sounding objects for the audience are positioned also in a nonuniform way. The concert-installation could be adapted also for non open halls, having the “islands” installed in various rooms and the “sky” in corridors or different rooms.

A presentation of the concert-installation took place at 3rd of March 2017 as part of the Junge Signale concert series in MUMUTH György-Ligeti-Saal in Graz. The 32 loudspeaker system of the hall were divided into a “sky” with 20 speakers and 3 “islands” with 4 speakers each. The presentation included 3 instrumentalists performing the violin, alto saxophone and bass clarinet.

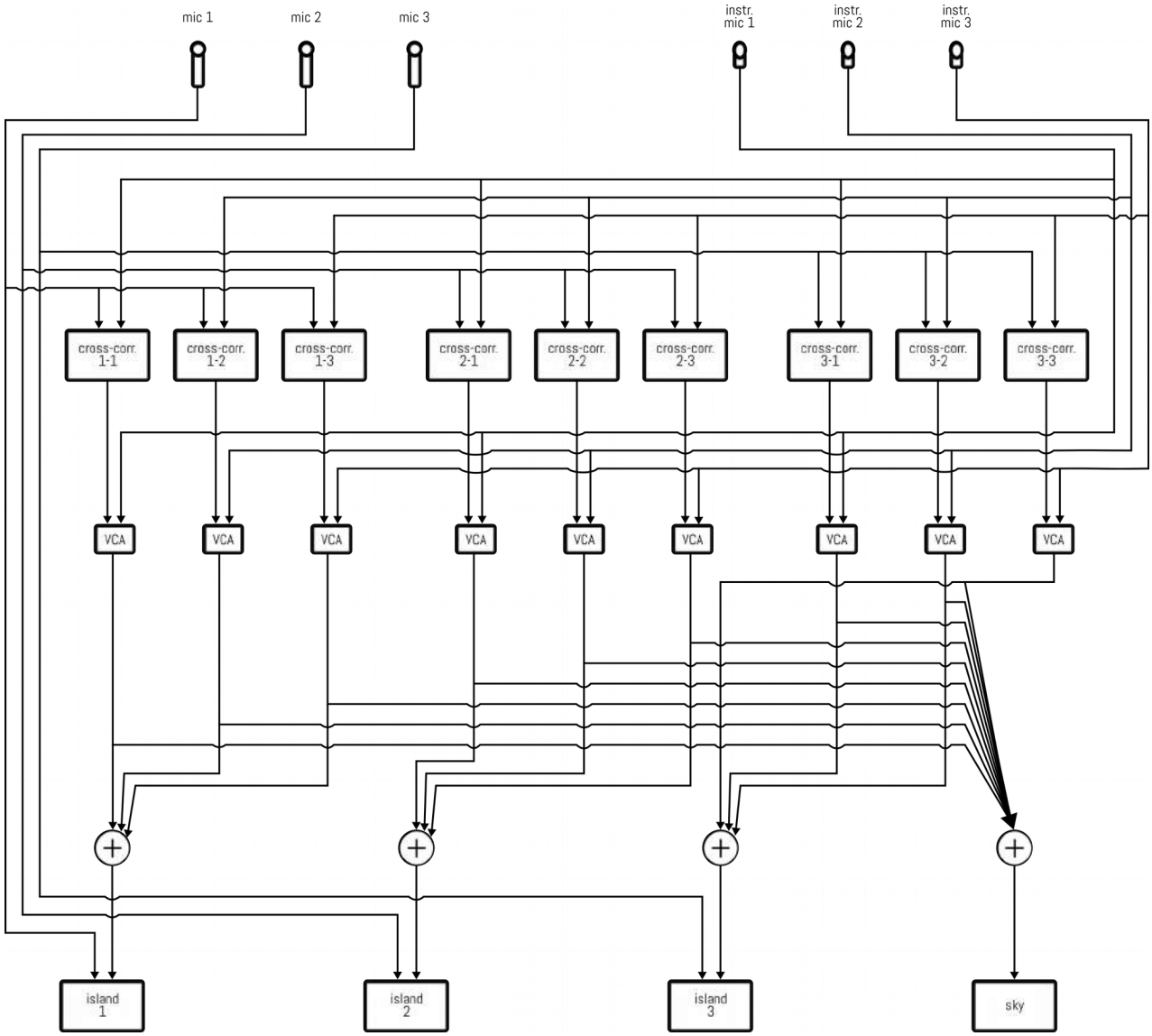


Floor plan of the György-Ligeti-Saal with the loudspeakers, “islands”, chairs and tables outlined.

Sitting audience members.

5. Computer music system

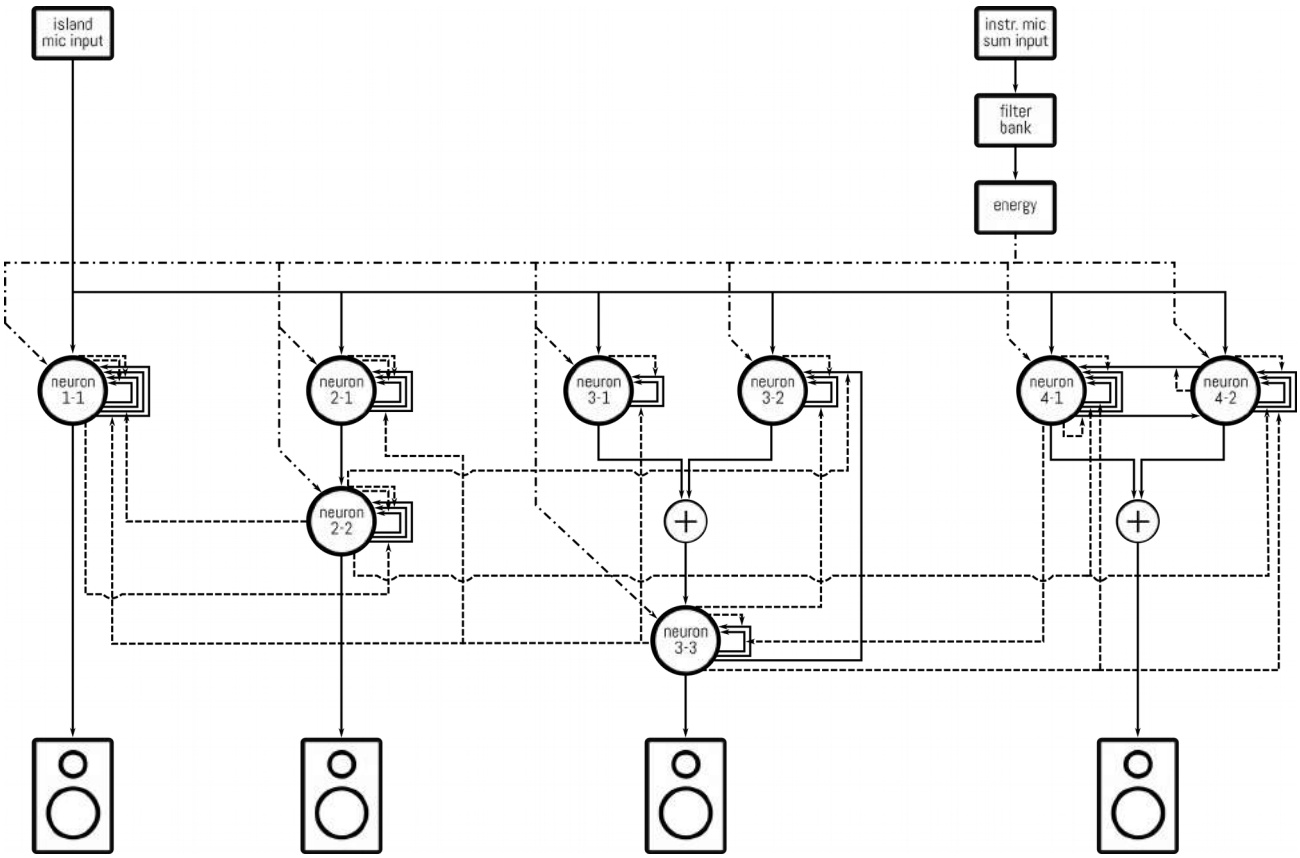
The computer music system continuously evaluates a real-time DSP algorithm, which is a windowed real-time cross-correlation between the audio signals of the “island's” microphones and the instrumentalist's microphones. The low-pass filtered energies of the cross-correlated signals modulate the amplitude of the corresponding instrument microphone signals, working as a sort of voltage-controlled amplifier. The software module for each “island”, receives the audio signals from the corresponding microphones and the sum of the respectively amplitude-modulated instrument microphones signals. The software module for the “sky”, receives the sum of all amplitude-modulated instrument microphones signals



Flow diagram for the cross-correlation operations and routings.

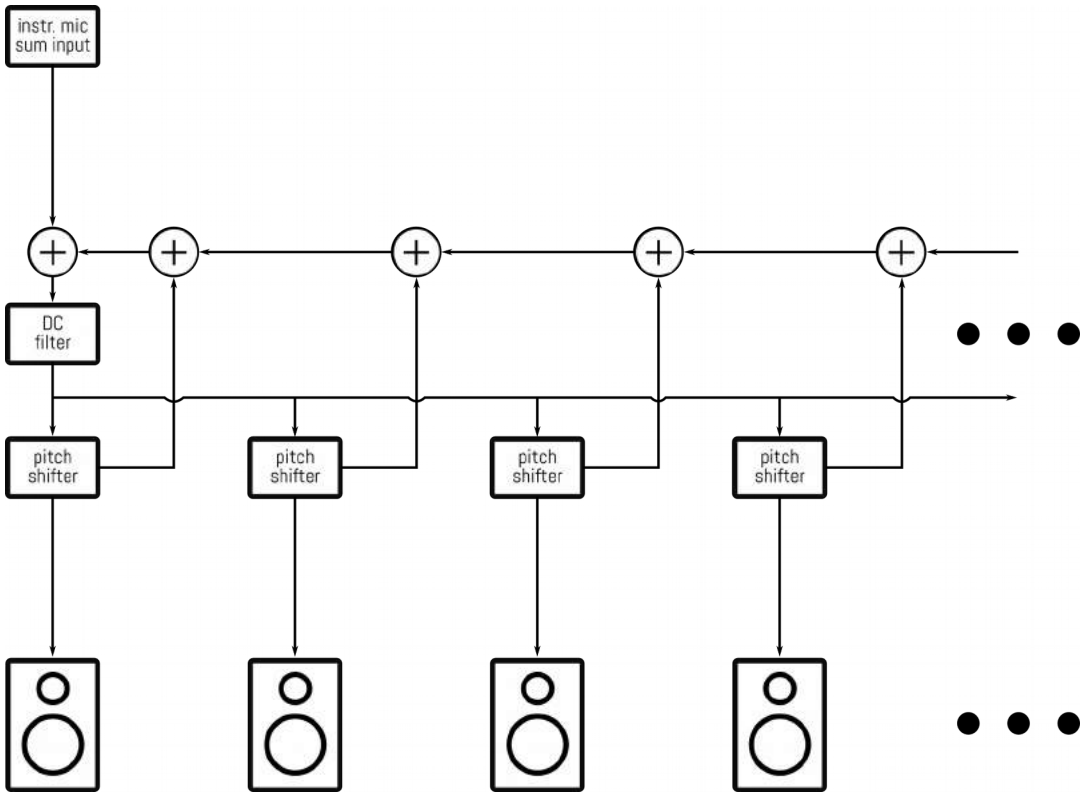
The software module for each “island”, is an feedback network inspired by neuronal processing. The incoming signals in a digital neuron are mixed, passed through a DC-filter and compressed through a look-ahead RMS detector. The output is fed back to the same neuron or to other neurons, forming recurrent network topologies and acting as dynamic oscillators. The connections or digital synapses, are time-varying delay lines, implemented with the Lagrange interpolating polynomial of degree 3. The low-pass filtered energy is extracted from the neurons and mapped to the delay-times in the digital synapses (dashed lines in the diagram). The neurons modulate their own synapses (self-modulation) or other synapses in the network (neuromodulation). This technique is inspired by biological neuromodulation which is the physiological process by which neurons use chemicals to regulate diverse populations of other neurons, in order to achieve lifetime learning abilities.

The incoming sum of the modulated instrument microphone signals is analyzed by a filter bank, and the low-pass filtered energy is extracted for various frequencies. These energies modulate some neuron parameters and some second-order synaptic plasticity parameters of the synapses in the network (dash-doted lines in the diagram).



Flow diagram of “island” digital network topology used for the Mumuth performance.

The software module for the “sky” is a modified feedback delay network. Each delay line is implemented as a classic rotating-tape-head style pitch shifter. The pitch shifted signals are routed to the loudspeakers and fed back, mixed with the incoming signal and pass through a DC filter. This modified feedback delay network uniquely expands every incoming sound in time, space and frequency. The transpositions and maximum delay time of the pitch shifters can be arbitrarily composed for every performance. The maximum delay time should be at least 30 seconds. For the performance in Mumuth, equidistant intervals of perfect fifths (ratio 3/2) for both time and transposition were used.



Flow diagram of the modified feedback delay network used for the “sky”.

Each “island” and the “sky” software module run in different Pd instances, utilizing a different processing core. They receive the audio inputs from the cross-correlation patch, which runs also in a different Pd instance, through the Jack server audio kit. With more powerful computers, more complex topologies may be implemented for the “island” software modules, resulting to more variable behavior. Different network topologies can be implemented for each “island”. For the Mumuth performance, the same network topologies for all “island” was implemented, having different loudspeaker routings.

6. Performance rules

The actor groups that can interact with the spatialized computer music system, are the microphonists, the instrumentalists and the audience. The microphonists and instrumentalists learn and practice their performance rules in the rehearsals, while the audience members discover their role in the public performances.

Microphonists

The microphonists are responsible for the musical behavior of their “island”. These human agents extend the algorithmic dynamics in the performative domain, modulating the position and direction of the microphones. A change in position and direction of the microphone alters all the weight, time-delay and filter parameters in the local network. The microphonists can move freely about their responsible “island” and improvise gestures that provoke musical responses. At some specific combinations of position and direction of the microphones, the generative network can be steered towards recognizable audible states. The microphonists have to find and learn where such spots can be located and revisit them freely in their improvisation in the public performances with audience.

Microphonists performing in their “islands”.

Audience members, by producing sounds near the “islands” with the exhibited sounding objects, invite the responsible microphonists to come nearby and point their microphones towards this different type of sound source. The incoming sounds will perturb any dynamic behavior of the generative network, while they will be amplified and filtered at the same time. The microphonists can also ignore produced sounds from audience member if they find them musically inappropriate at that specific moment.

The same situation can occur with the instrumentalists. The difference is that the instrumentalists carry microphones in their instruments, which allows the cross-correlation algorithm of the computer music system to be activated. If a microphonist approaches the instrumentalist(s), then the incoming signal(s) will get access to the diffuse network of the “sky”. At the same time it will modulate some second-order plasticity parameters of the generative network, modifying its generative character and changing the recognizable audible spots. Multiple instrumentalists can approach an “island” at the same time while the microphonist have to decide which incoming sound sources are musically more relevant for their “island” and point their microphones towards the proper direction. The microphonist can improvise freely with the instrumentalist(s), going very close to the instrument (e.g. inside a bell of a wind instrument), moving the microphone with various speeds across the instrument(s) or alternate microphone positions-directions between different instruments or loudspeakers.

The microphonists can perform two types of gestures of symbolic meaning for the instrumentalists. When they are alone in their “islands”, they can let the hanging microphone swing freely while they stay in a close distance. This sign is an invitation for the instrumentalists to come and improvise in the “island”. The microphonists can perform this sign if they feel that their networks need some character modification, so that they can attempt new improvisatory actions. The second sign can be performed when instrumentalists are inside the islands and the

microphonist wants them to abandon it. The instrumentalist can point the microphone very close to a loudspeaker for a prolonged time. This gesture will cause a characteristic audible stability in the generative flow.

There will be situations where the “sky” will be very loud, so that the generative streams in the “islands” are not audible anymore. When such situation occur, the microphonists can depart from their “islands” for a while and turn themselves into listening agents (like audience members). They can return to their “islands” when the “sky” calms down and the generative streams become audible again.

Instrumentalists

The instrumentalists are the human agents that can massively disturb the sonic equilibria in the local networks and drive the ecosystem to its extreme states (with the assistantship of a microphonist) by inserting enormous amounts of sonic energy into the diffuse network. Only the musical instruments that permit playing while moving can be used and the heavy instruments (piano, harp, etc.) are not eligible for this performance ecosystem.

The instrumentalists try to play musically in every position they are situated in. They move around in order to find suitable spaces that musically fit their improvisation. All other agencies (“island”, “sky”, audience members, other instrumentalists) offer possible spaces for musical interaction. If the musical activity of the instrumentalists attracts the microphonists, their gestures will be diffused by the “sky” and spread through the concert hall.

The interaction with other instrumentalists can have a cooperative or competitive character. In the cooperative mode, two or more instrumentalists approach each other and form a small ensemble that can be approached by the microphonists. These ensembles have more chances to be picked up, modulate an “island” and get access to the “sky”. In the competitive mode, two or more instrumentalists approach an “island” from different directions. They keep their distances and try to win the favor of the microphonist with their improvisatory skills. In these case, the instrumentalists have less chances to be picked up but they achieve exclusiveness in the diffusion of their sound, if they succeed in winning the microphonist.

Another interesting side-effect the computer music system allows, is that instrumentalists can get access to the “islands” and the “sky” from distance. This is possible because the cross-correlation algorithm runs continuously for all “islands” and instrument microphones. If a microphonist and an instrumentalist are engaged in an close interaction, other instrumentalists outside the “island” can try to pitch-follow the improvisation of the instrumentalist inside the “island”. The “island” microphone signal and the instrument microphone signal inside the “island” will correlate in a high degree, since they are very close. The instrument microphone outside the “island” capturing the pitch-followed signal, will correlate also in some degree with the “island” microphone signal. This situation is referred as “hacking”. It is even possible for the instrumentalists to “hack” in some degree isolated generative streams in the “islands”.

Saxophone player picked up by a microphonist.

Violinist and clarinetist playing competitive.

Saxophonist, violinist and clarinetist playing cooperatively.

Sounds from audience members picked up by the microphonists can only mildly perturb the generative stream. If the instrumentalists approach such interactions playing very subtle sounds, then these sounds will be recorded by both microphones and get cross-correlated. This is the only way of letting sounds from audience members to modulate an “island” and get diffused into the “sky”.

At any moment, the instrumentalists can switch to a listening mode and behave like a listening audience member. These listening intervals can be as long as the instrumentalist finds appropriate, until a suitable space for improvisation is found.

Audience members picked up by microphonists. In the second picture the saxophonist help the sound of an audience member to be entered into the “sky”.

Audience

The audience members are invited to sit in the chairs, move around, make sounds with the exhibited objects while moving or staying in a fix position. Their role is uncommon for a concert situation and the following text is provided together with the program note at their entry to the concert hall, in order to introduce them to a new role:

From this moment, you are part of a sonic ecosystem. Feel free to move about, find captivating listening spots and conduct your own listening expeditions. You can contribute to the sonic discourse with sounds that you can produce with the exhibited materials. You can rip apart baking papers, crumple aluminum foils, brake bubble wraps or rub sand papers. Do that in your favorite listening spots or while moving. If the microphonists and instrumentalists realize your creative contribution, they will come close to and play with you. This will allow your sounds to enter the computer music system and affect the dynamic generation and diffusion of sound. Try to discern the global sonic tendencies of the ecosystem and act according to them or against them. Give space to other performers for their actions and listen or infiltrate in current interactions and play along with or disturb them.

Audience member disturb the generative stream in an abandoned “island”.

7. General instructions

For the rehearsals, isolated scenarios should be tried out (e.g. rejected pick up, cooperative/competitive play, “hacking” etc). The final and general rehearsals should be free, letting the agents to act on their own will. Any planning of the dramaturgy should be avoided, although it could be applied in the case of short performances (up to 30 minutes). Collective behaviors of diverse sonic intensity should be able to emerge.

The concert-installation should be ideally presented as a non-stop installation throughout the whole duration of a festival. It should be accessible 24 hours a day by audience members and musicians who would like to interact and play with the system. At specific announced dates and times, performances as concerts should be scheduled. These concerts can take place at any time of the day and night. They should be rehearsed performances with experienced microphonists and instrumentalists. The performers should enter the hall, start the performance and after reaching a predetermined state, leave the concert hall. The predetermined conditions can be a time interval or performative achievements (e.g. when 3 competitive/cooperative interactions occur, or 5 “hackings”, or when the audience members are not interacting for 10 minutes etc.). There should not be any applause events from the audience in the beginning or the end of a performance.

Performers and audience member exiting the hall without an applause event, with the computer music system running.

8. Theoretical remarks

“Attractive Correlation” offers a radical performance and presentation setting that balances out the problematic of the reduced ability of experiencing some of the relationships between the involved agencies. It is designed for enhanced interactivity via sound with specific mechanisms that promote the attention and sensation of the dynamic experience of the performance. Its hybrid presentation format combines the temporal intensity of a concert with the scattered loci and the diverse listening modes of a sound installation. The performance space is situated as an acoustic arena, articulated by various small stages and spots for contingent interaction. With the dissolution of the main stage, as the center of action and attention, the unilateral exploitation of activity is reduced. Instead, parallel activities can take place, which due to collocation, exert balancing forces to each other.

The installative setting puts constrains to the potential behavior of the human agents and affords specific actions which revolve around the performance of listening. The setting invites the audience members to listen while moving about, sitting or producing sounds with the available objects. The freedom of alternating between these listening modes, interdependently for each audience member, can provoke collective behaviors of inter-subjective experience. The performative agents, divided in the instrumentalist and the microphonist groups, posses similar degrees of freedom and some special capabilities which can be used for driving the ecosystem into some extreme states. These short-lived extremities can emerge in the course of a performance but the ecosystem will inevitably revert to the stable equilibrium of higher entropy.

The computer music system is implemented as a multichannel input-output system that operates and process information at audio rate. Its generative music abilities originate in the dynamic oscillators organized in compound ensembles. Basic features from the incoming and internal audio signals are extracted in multiple time-scales, which subsequently modulate some other control parameters in the DSP flow. Emphasis is given to a dynamical signal processing which excludes rigid and hard-programmed routines like sine waves and wavetable synthesis methods. The effect in the generated sound is a diminishing influence of the agency of technocratic determinism and a highlighting of the audible traces, caused by the actions of the human agents.

The performance of the microphonists, can be considered as the extension of the algorithmic dynamics in the performative domain. Intimately coupled with the computer music system, they act as a heuristic mechanism that wander chaotically around the search space (“island”) until they find a spot that adequately satisfies their musical taste at that particular moment. A similar perspective is described as “*machine performing*” (Choi 1994, 2017) although the performance is mediated by audiovisual interfaces. In the author's pieces “Contraction Point” and “Self-Sustaining Play”, complicated performative protocols are executed by performers via audible means.

The lack of tradition in such experimental settings pose difficulties for the initiation, engagement and responsiveness of the audience members. Their conventional expectations have to be suspended with an initiatory pre-concert event in a different location, where some of the aforementioned principles can be explained. The objective is to stimulate their interest and also to create a sort of group identity. The beginning and termination of the performance has to be concealed. After the initiation phase, the audience will find itself inside a performance ecosystem where undiscovered rules of engagement are in effect. This technique will provoke a curiosity response and will divert their anticipatory tendencies. The end of a performance can be signaled by the opening of an exit door, whereby the audience can leave at any desired moment without any applause. The goal is to avoid the distraction of the presence of a human agent (composer, sound engineer) who have ultimate control over the performance, since he/she poses the ultimate power to activate and terminate the computer music system.

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