“NATURAL SELECTION: A STETHOSCOPIC AMPHIBIOUS INSTALLATION”

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Abstract

This paper discusses emergence as a complex behaviour in the sound domain and presents a design strategy that was used in the creation of the sound installation *Natural Selection* to encourage the perception of sonic emergence. The interactions in *Natural Selection* are based on an algorithm derived from an innately sonic emergent ecological system found in nature, that of mating choices by female frogs within a calling male frog chorus. This paper outlines the design and implementation of the installation and describes the research behind its design, most notably the notion of embodiment within a sonic environment and its importance to the perception of sonic emergence.

1. Introduction

A fascination for models derived from natural organisms has a long history of influence within the arts. In recent years, there have been numerous implementations of algorithmic systems that model the phenomena of emergent behaviour. In an attempt to reproduce the necessary conditions for emergent behaviour to occur, these systems employ bottom-up strategies through the definitions of simple rules for the behaviour of local agents.

In the context of sound design, a potential problem with many of these systems is that the algorithms they are based on do not derive from sound but typically from a system that exhibits perceived emergence through the application of graphical (Boids) [13] or evolutionary (Genetic Algorithm)[1] models. The implementation of these algorithms to a sound world is then based on a more or less arbitrary mapping procedure between a graphical and a sonic model.

The installation described here attempts to sidestep issues pertaining to the mapping of graphical to sonic emergent systems by designing the work through a carefully selected natively sonic emergent environment with special consideration given to the notion that the phenomenon of emergence is manifest in the dynamic listening system of a perceiver embodied within the environment.

We have argued elsewhere [3] that the modeling of emergence is linked to how we perceive it. In the context of emergent sound we feel it is important to model behaviour that features intrinsic aspects of emergence in the acoustic domain, in contrast to arbitrary mapping between domains.

> '*In the same way that behaviours such as flocking are better understood from a distance, we argue that sonic emergence can only be perceived when considering the listener as an agent of that very behaviour. The ear does not act as a stethoscope, listening in from the outside, but rather as a participant in a space in which it takes the role of one, of many agents.*' *(Davis and Rebelo) [3]*

2. Ecological Model

This installation is based on the listening ecology found in the model of female frog mate selection within a calling male frog chorus. Through a study of current research into the mating of frogs we have found that female frogs select a mate from within the male frog chorus according to information afforded to them through the temporal and spectral characteristics of their calls [5]. Frogs have a complex auditory system that is designed to help them recognise and respond to calls of their own species. They have a variety of different calls for such situations as mating, distress, release, warning, rain and definition of territory. The calls for different species are distinct in temporal and spectral characteristics. This helps the frogs recognise calls of their own species within a dense chorus [11].

The mating calls of frog species under study can be characterised by four main parameters: dominant call frequency (the frequency with the highest spectral intensity), pulse rate, call rate and call duration. With dominant call frequency relating to frog size, pulse rate relating to the ambient temperature of the environment, for example the water temperature, and call rate and call duration relating to the preference of each individual animal [8]. The characteristics that were found to have the most effect on female choice of mate, were dominant call frequency and call length [8]. It was found females preferred longer lower calls, the pitch of the calls having a strong correlation to the body size of the males and thus their successfulness in mating. It has been found by Wollerman that a “female frog could detect a single male’s calls mixed with the sounds of a chorus when the intensity of the calls was equal to that of the chorus noise” [14]. Given that there is a 6dB fall off in the intensity of the signal with each doubling of distance away this means that for an average spaced chorus (0.08 males per metre^2 [14]), the female can only distinctly ‘hear’ between three and five males at any one time

This installation is based on a simple model of the interactions found between the male frogs in the chorus with the user taking on the role of the female. Each male frog is represented by a mechanical 'sound object', which consists of a resonator excited by a motor. These sound objects have been designed to represent the four main characteristics of the male frogs call: the size of the resonator being linked to the dominant call frequency of the frog; the pulse rate is variable dependent on lighting conditions (each "frog" is fitted with a light sensor the output of which is affected by the user's location causing disturbances to the light source); the call duration is fixed but different for each frog.

2.1. The Algorithm

The rules that govern the local interactions between the males are based on research that suggests that female frogs prefer 'leading males', i.e. males that are perceived by the female to be calling in front of the other frogs. [7]. To produce this effect the male frogs listen to their nearest neighbours (the others being masked by the noise of the chorus) and consciously alter their call rate so as not to coincide with other males. To model this interaction each "frog" has a set call rate which is modified through the application of an algorithm based on a resettable oscillator. Each of the frogs is wired to its two nearest neighbours to resemble the listening conditions in the wild [11]. If a "frog" 'hears' a neighbour making its call, by virtue of receiving a current down a wire it resets its oscillator to 1 thus inhibiting its own call and lengthening or shortening its own call rate. The local interaction between the male frogs is the algorithmic structure that has been set up to exhibit emergent results. The temporal form of the piece is not only governed by the frogs own set call rate but by the interactions of the frogs with their nearest neighbours.

> *'Form is a dynamic process taking place at the micro, meso and macro levels. When properties not explicitly determined by specific parameters emerge at different levels, we witness a pattern-formation process. In this case form is not defined by the algorithmic parameters of the piece but results from the interaction among its sonic elements. in a general sense higher level forms or behaviors resulting from interaction of two or more systems' [9]*

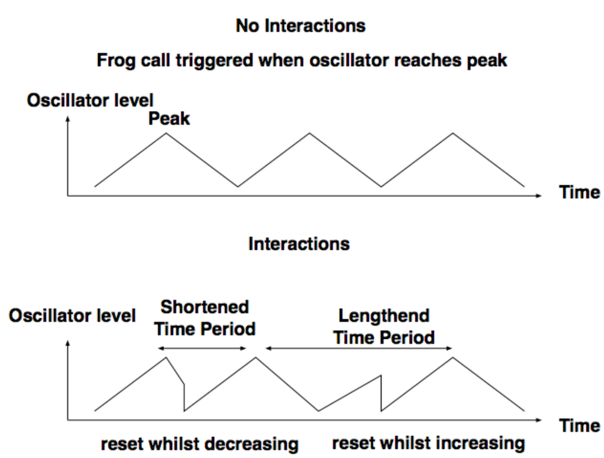


Fig 1 Resetable Oscillator Model

2.2 Design Considerations

This installation attempts to promote a 'learning through interested interaction approach'. [12], thus there are no instructions or rules set out for the user to follow and there are no prescribed levels or modes of interaction. If this approach is to work it is important that the installation compels the user to interact through generating interest in the sound objects, it is also important that the user feels free to approach these sound objects and that the spatial setup of the installation allows for a liberated mode of enquiry. Since there is no statement of artistic intention for the piece the mode of communication between the sound objects has to become apparent through interaction and investigation. To make this communication explicit a network of wires suspended between the objects suggests links and interactions within the installation space. This suspension is well-over head height and suggesting an enclosed but accessible space, hopefully encouraging visitors to "enter" the space inhabited by the sound objects.

The sound objects were first laid out in a circular form, [Fig 2], so as connections to their two nearest neighbours is easily obtained. The order of the sound objects is then shuffled [Fig 3] to generate a more non-linear spatial structure, so that it is now possible to stand within the proximity of a small cluster of sound objects, or to move to a more open space dominated by fewer objects. We will argue later that this facility for the user to define their level of engagement and embodiment within the piece is important in leading the ear in the perception of emergence.

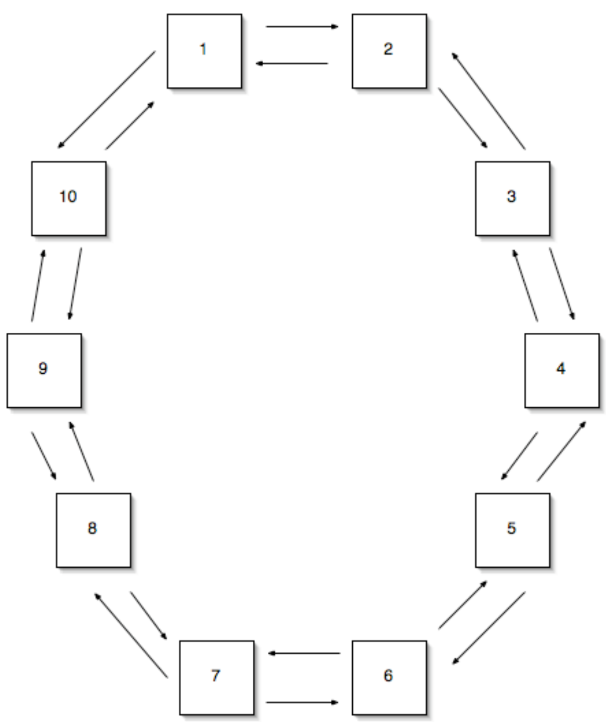


Fig 2, Interaction Layout 1

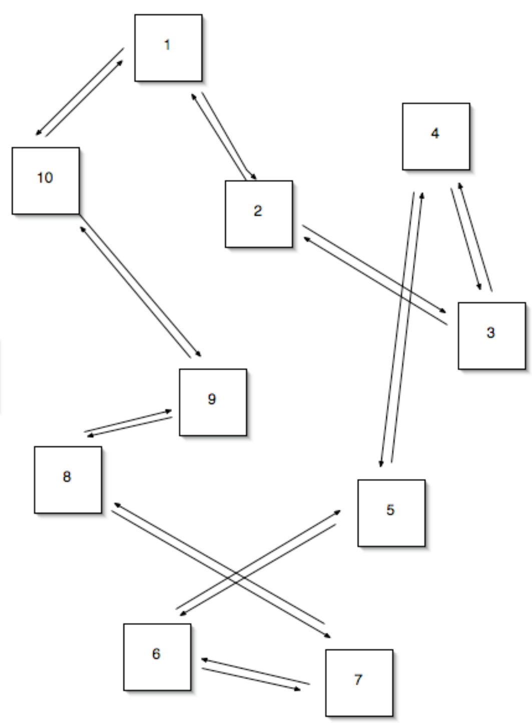
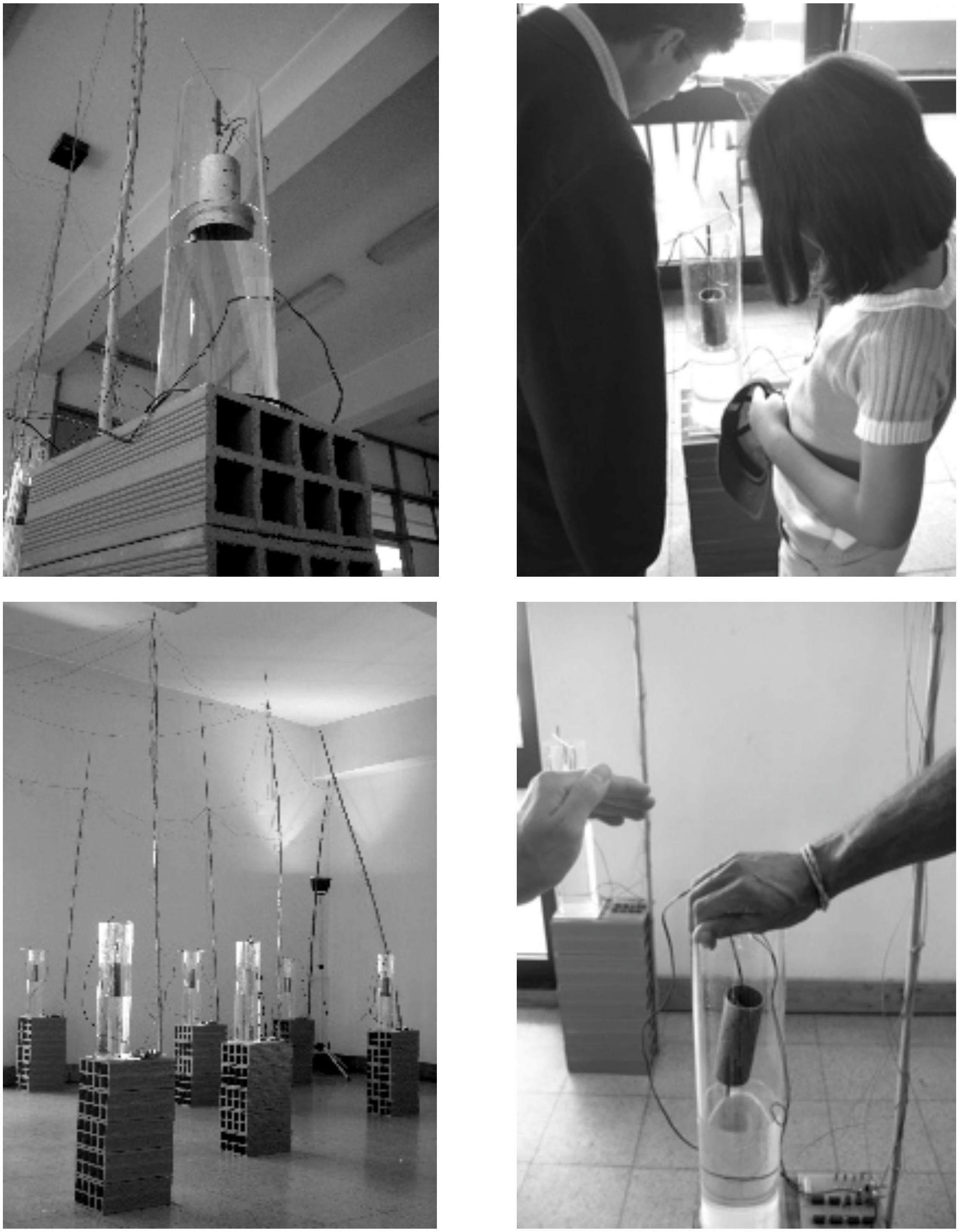


Fig 3, Interaction Layout 2



Figures 4 – 7, Photos of installation at Música Viva Festival 2005, Portugal, detailing set up and interaction.

3. Embodied Perception

An important design feature of the installation is that the female frog, the one who makes “aesthetic” judgments of the males, is actually embedded within the environment herself. This embodiment within the environment is important to the aural perception of emergence highlighted in Edmud Husserl’s [5] notion of zero point of orientation:
"the body then has, for its particular Ego, the unique distinction of bearing in itself the Zero point of all these orientations. One of its spatial points, even if not an actually seen one, is always characterized in the mode of the ultimate central ‘here’: that is a here which has no other here outside of itself, in relation to which it would be 'there'" [4]
Husserl’s ‘Zero point of orientation’ places our own ‘lived-body’ as the zero point of reference, such that everything, be it actually perceived or even imagined is orientated towards it. Notions such as near and far, left and right are now considered with reference to this Zero point, far becomes far from my body and left, left of my body in such a way that all perceptions have their pole of reference contained within the body. The understanding of emergence in the aural domain can benefit from Husserl’s work in respect to a shift away from a Cartesian top-down perspective of the world to one in which the observer/listener perceives the world only in relation to him or her own body.
‘Whereas one can be a (visual) observer, treating the world in front of us as a spectacle viewed from a certain perspective, aural stimuli are mapped around our own body. This difference in role raises issues of engagement and participation, which place the ear in a rather unique position. It is the trajectory performed by the ear, from a subtle tilt to the movement of the body as a whole, that becomes an active participant in the perception of an auditory scene.' [3] Thus in this installation the user is encouraged to take on the role of the female frog, moving amongst the males, going on a journey through the sound world, searching out sounds that they find aesthetically pleasing and constantly shifting their listening from a micro (single frog) to a macro (chorus of frogs) level in the hope that this level of immersion within the environment will help develop the perception of emergence.

> 'the perceiver is a an active searcher for information available for him and suitable for this physiological constitution. Beyond the fact that the environment shifts the stimuli, also the perceiver shifts it as he moves his body head system around.' [10]

3.1. Levels of Interaction and the Perception of Emergence

An important design feature of this installation is that interaction is present on a number of levels. The sound objects interact on a temporally structural level with each other; the user interacts with the sound objects disrupting their sound; the embodied user also interacts in traversing the environment on a spatial and perceptual level.

These varying levels of interactions were designed to encourage a perception of emergence that becomes manifest when the perceiver is forced to change their frame of reference with respect to the subject matter, as outlined in Cariani's [2] concept of emergence as emergence relative to a model.

> 'Once we have fixed our observation frame we can talk precisely about emergence: whether the behavior of the physical system has changed with respect to the frame and in what ways it has changed' [2]

An example with a graphical model of emergence such as Craig Reynolds' Boids [13], is that it is only when you take a step back and view the system as a whole that the pattern formation between the agents on a global level becomes observable, and it is in this perceptual state change of the user that emergence exists.

This can be linked to Holenstein's critique of Husserl's Thesis of the Zero point of orientation in which he expands the Thesis to suggest a structure that consists of a plurality of orientation in which "...the most powerful figure in each context functions as the zero point of orientation of perception. Its power is founded in gestalt and sense function. In order to obtain the role of zero-point, it must dominate the rest of the perception by virtue of its gestalt or special meaning that is attributed to it no differently than to objective things." [6].

It can be argued that principally in the audio domain the 'lived-body' centralises as the zero point of orientation as it is functioning as the dominant figure of perception. In 'Natural Selection' however, the visitor is encouraged to alter their level of engagement with the sound world from the micro (frog) to macro (chorus) level, to seek out certain sounds within the environment and approach the sound making objects. On interacting with the sound objects however their light source is cut off and the objects' sound is disturbed or discontinued. This then encourages the user to lose interest in the sound object they have chosen and listen again on a more macro scale taking in the sound of the whole chorus of sound objects from their new position relative to the user. The visitor is thus presented with a plurality of orientations and is encouraged to alter their zero point of orientation oscillating between localizing on themselves (the 'lived-body'), a single sound object, a spatial group of their own making or the installation as a whole.

4. Conclusion

We have discussed the notion of embodiment in the context of the perception of emergent systems in the sound domain. The installation "Natural Selection" served as a vehicle for practice-based research in the area of emergence and its perception. By investigating natural emergent systems, which manifest themselves primarily in sound, we can gain some insights into the possibilities of sonic emergence. From the research presented here as well as in earlier work we can identify the importance of the notion of embodiment. Thinking of the body as part of an emergent system rather than as an observer, suggests an approach that is different from most of graphic-based modelling work. ‘Natural Selection’ proposes a hybrid world which attempts to suggest a level of engagement based on the notion of a sound ecology.

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