Feeping Creatures - evolving musical agents for sound in virtual worlds

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Abstract

I am a composer and audio-artist with a keen interest in artificial life and virtual worlds. This paper describes some of my recent work in this area and touches on aspects of its execution and motivation. The interactive virtual environment, Feeping Creatures generates music and graphics in real time based on the evolution and behavior of a population of artificial organisms. The work is described along with the aspects of my current Vital Presence project at ATR Media Integration and Communications Research Laboratories in Kyoto. Along the way, I find opportunities to share my opinions on various issues surrounding this kind of work, and speculate on the implications and future directions of my own work.

Key words: virtual reality, artificial life, evolving music, VR sound, VR aesthetics

1. Introduction

As a composer, musician and audio-artist, I soon became dissatisfied with the passive way in which music is traditionally experienced. I didn't feel that music should be something that you sit down and have done to you. This dissatisfaction led me through many explorations of possible solutions to this problem, each in turn opening up fresh problems and creative challenges. I wanted to make music which could be traversed in a non-linear fashion as one might approach a painting or sculpture. It is not surprising then that I have become a maker of virtual worlds.

Over the last 14 years, I have produced a number of sound works in a variety of media. All of these works have been concerned with exploring the intangible boundaries between animate and inanimate, technology and biology, art and science. Central to most of my work is a desire to create for the audience, a sense of vital presence, of being in the presence of a living thing. The early works included fairly large physical sound installations and sculptural musical instruments. Initially I tried to avoid electronics in favor of mechanical sound production, but later works often used hybrid mechanical and electronic systems. Computers were used to automate the mechanisms. There came a point however where, despite finding ingenious ways to make the works collapsible and easier to store, my garage became full of old sculptures and sound-making machines. It was clearly time for a leap into the realms of the virtual.

My early experimentation with automata and systems led me to a renewed fascination with biology. I found the natural world rich in metaphorical material for the artist and my attention turned to the nature of life itself. Through my work, I continued to ask, "What is the boundary between animate and inanimate and to what extent can some of our artifacts be described as alive?" I had seen several ecological simulations on computers and wondered what it would be like to make one that used music as an integral part of its functioning. After some attempts to write the software myself, I realized that I lacked both the programming skill and the computing power for the task. I shelved the idea for a few years and went back to making giant solar-powered pipe organs. After reading Artificial Life by Steven Levy, especially the part about Larry Yaeger's Polyworld simulation[1], I began to seriously investigate ways of creating some musical lifeforms of my own.

2. Feeping Creatures

Feeping Creatures is an interactive virtual world. It was developed over the last three years in collaboration with programmers Tom Mander, Brian Murray and Ben Ross of Proximity Pty.Ltd., a Sydney-based software company. The development was assisted financially by the Australia Council, the Australian Government's arts funding body. The title is a spoonerism or word play on Creeping Features, the tendency among software developers to cram so many features into a program that it becomes overweight and clumsy. The name was chosen to remind the programming team and myself to keep this piece as simple as possible. The ideal is to see how much variety and complexity can be generated with a bare minimum of complication. For my purposes, complexity is what emerges in nature as a result of interactions between essentially simple interdependent elements. Complication on the other hand, comes from human attempts to create the outer appearance of natural complexity. The latter approach tries to carve a tree out of a blank block of wood while the former simply plants a seed and waits. My own ultimate goal in this area is to create a perpetual novelty engine. Left to its own devices, such a machine would go on forever producing new and unique output independent of the hand of its creator. In nature, the process of evolution is such an engine of variation, perpetually churning out diverse forms and behaviors. This is why I chose to explore artificial life and evolutionary computing for their potential to bring life-like qualities into my own artworks.

The world of Feeping Creatures is a flat green grid across which the inhabitants (feeps) and the observer move. Feeps are represented by simple cubes covered with moving textures. Food is represented by green triangular pyramids (trees) that grow up through the floor of the grid. The user of the program moves a mouse to steer a virtual camera and its attached virtual microphone across the grid. A projected video screen shows the view from the camera while loudspeakers play the sounds collected by the microphone. Each feep has a sequence of musical pitches that form its chromosome. These are mapped to MIDI note numbers that are sent to an external synthesizer (in this case, a Kurzweil K2000). When two feeps mate, portions of each parent's note list are passed on to their offspring to form a new chromosome or pitch series. At birth, a feep is randomly assigned a numerical value to determine its preference for mating. If this value is high, the new feep will seek out partners that are, on average, musically consonant to its own note series. If the value is low, its preference will be for those more dissonant to itself.

The degree of consonance or dissonance is found by first finding the difference between the first MIDI note numbers of each series. The result is then divided by 12 while keeping the remainder (modulo 12). This returns a value of less than 12 that is then compared with a hierarchical table of intervals. The unison or octave would have a value of 0 (most consonant), and the semitone a value of 11 (most dissonant). The remaining intervals fall between these extremes in an arbitrary order. The hierarchy could easily be changed and would also apply to microtonal (using intervals less than a semitone) even-tempered tuning systems. The process is then repeated between every note in both lists before averaging out the results. By tabling these results, the program can keep track of who will mate with whom in the world of the feeps.

In musical terms, we are only dealing with average vertical harmonic relationships. A similar process could be used to find average horizontal relationships as well. For the moment, voice-leading and octave displacements are ignored (except for the fact that young feeps transpose down a few octaves when they reach puberty) in favor of a quick and dirty calculation of general trends in the population. I am looking for a similar method of dealing with rhythmic information. Different ways of ordering and evaluating proportions of durations and articulations are currently being explored. The challenge is always to find simple formulae, which, although imprecise, give the system (and its internal components), some general ideas about its own internal states.

In Feeping Creatures, rhythm is analogous to energy flow through the system. Each item of food (tree) contains a duration value (how much time passes before the next note is played) and an articulation value (how long the note sustains once initiated). When a feep finds a tree and eats it, the tree's duration and articulation values are added to the feep's rhythm list. Unlike the pitch list, which is fixed at birth, the rhythm list increases when the feep eats a tree and decreases as it ages or fails to find food. When a feep's rhythm list falls below a given length, meaning its energy level is low, the feep dies and vanishes from the world. Because rhythm is dealt with separately to pitch, repeated cells of melodic material cycle with rhythmic figures of a different length. Different parts of the melody return with other parts of the rhythm in each subsequent cycle. These note/duration isorhythms manifest as short repeated patterns somewhat like bird songs.

The main program oversees all the interactions between the feeps, their positions and the position of the user. When a feep is within an arbitrary hearing range, the program assigns it a new MIDI channel and a timbre that corresponds to its visual texture. The texture is one of 8 animated texture movies that are mapped onto the cubic shapes. As a feep comes nearer to the microphone, its MIDI volume increases causing it to become louder. The program also uses MIDI to adjust each feep's location between left and right, front and back of the four loudspeakers. This is achieved by making a synthesizer voice consisting of two layers. One layer is assigned to the front left and right speaker pair and the other to the rear pair. Another MIDI controller is used to cross-fade between the front and rear output layers. Although cheap and crude, this method allows for up to 12 independently moving sound entities in the four-speaker field with no noticeable delay.

A great deal of care was taken to integrate sound, visual and kinesthetic information in this work. Much of our kinesthetic sense involves a convergence of cues from our senses of hearing, sight and touch. More broadly, this cross-modal cueing between different modes of perception is probably the most crucial factor influencing one's degree of immersion in a virtual world. The surround sound, coupled with the projected video and simple mouse interface, creates a sense of being drawn into the imaginary world of the feeps. The sound and visual outputs change to provide instant feedback to the user as he or she moves the mouse. I believe that it is this integration of stimuli that makes it easier for the user to be absorbed into the work. This kind of absorption or engagement is not necessarily brought about by interactivity. In my opinion, many multimedia presentations quickly lose engagement through gratuitous interactivity. A microwave oven is interactive. It has buttons, even a bell that rings. A good painting can be deeply engaging without a mouse and buttons to press. Engagement comes from addressing the user at many levels simultaneously. It is my hope that multimedia will move away from its current fixation with pointing and clicking through a fixed database toward something more fluid and organic.

It has become apparent to me that Feeping Creatures will never be finished. I guess that no world ever really is. The ecology badly needs a predator, a feep-lion to prowl the landscape devouring feeps and incorporating their rhythms. The feep-lion would hunt by analyzing the rhythmic content of its prey and perhaps the melodies as well (something like a virtual music critic). This would influence the evolution of pitch series along more diverse lines than the simple sexual selection currently in operation. The environment itself will become more of a shaping force for evolution including terrain and weather as selective pressures on the evolving feeps. The goal is to create a complex system of deeply interdependent variables, which continually modify each other in an endless game of Rock, Scissors, Paper, the elusive perpetual novelty engine. For the time being, however, work on Feeping Creatures has been suspended while the programmers and myself are busy with other projects.

3. The Vital Presence Project at ATR's M.I.C.Lab

Currently, I am based near Kyoto, Japan at ATR's Media integration and Communications Research Laboratories as a visiting researcher. I am working with two student intern programmers to build another biologically inspired virtual environment. Similar in concept to Feeping Creatures, this project also uses an onscreen rendering of a 3D world and uses MIDI for sound. The creatures of this world are nicknamed Spinners because of their resemblance to children's spinning top toys. They have three sexes and all three must contribute genetic material for a successful conception to occur. Over the course of a spinner's lifetime, it changes sex several times. It begins life as a soprano with only one body segment and a relatively high-pitched voice range. At puberty, it becomes an alto with two body segments and a slightly lower pitch range. Altos initiate mating and bear the children with both a bass and a tenor. Later, an alto metamorphoses into a tenor with three body segments before finally becoming a bass with four segments.

Each spinner has a chromosome consisting of a long string of binary digits. Parts are taken from those of each parent to form a new and unique string. Segments of this string can then be mapped to different visual and musical traits. For example, the width and height of each body segment, is determined by the same parts of the chromosome as the durations and articulations of the creature's rhythmic elements. These musical traits provide values that are then used to trigger individual MIDI events. These MIDI events are fed to the outboard synthesizer, which turns them into sound. As rhythm is determined by genetic factors, we would expect rhythm to remain fairly consistent throughout a creature's lifespan (unlike in Feeping Creatures where the rhythm is continually changing). Melody is more dynamic, being governed by the way the creature responds to environmental changes in the form of neighboring creatures' activities. Timbre (the color or texture of the sound) is also controlled by the changes in the creatures' behavior and genetics. In practice, this means that parts of the chromosome are used to generate continuous MIDI controller messages. These messages control such timbral parameters as filter frequency and resonance, dynamic attack and decay rates and times. In this way, new individuals will have the same kind of overall instrument sound as their parents but each will have a distinct tonal quality.

At the time of writing, this project is still very much a work in progress. I expect it to go through many changes as it develops. We are trying a number of approaches to interactivity so the user develops a closer relationship with the work. One approach is to allow a live musician to create new creatures from what is played on an instrument. A kind of slow dialog would develop between the user and the system as new musical elements are added or culled by the player. Beginner musicians would have to be given a slightly easier way of doing this. The important thing is that the user or participant should feel that they are now a part of this artificial world and have a strong sense of being somewhere different.

4. Future Directions

In the future, I would like to make at least one environment in which graphics are virtually non-existent. I would like the sound to provide all the cues necessary for the user to have a meaningful experience with the work. Some of the digital convolution-based spatial sound systems appearing on the market will probably facilitate this kind of work[2]. However, I find such systems still when handling many moving sound sources and still prefer to use MIDI with four-way panning. I would also like to explore some models which are even less like the 'real world'. Such models could perhaps even evolve their own physics and biology. We invest so much of our resources in making jerky versions of normal reality. I am not convinced that simply throwing faster computers and more polygons at the problem will make it go away. Given different constraints, I think that current technology could give us a quite a fluid sense of something truly alien.

Finding ways to sonify existing artificial life environments is another avenue I wish to explore, where the mappings of state, location, actions etc. need not be so literal as in a typical 3D visualization. Another direction would be to treat sets of musical rules as the physics of an artificial environment. Such rules could be determined by a particular style of music that evolves creatures adapted to stylistic constraints. One could model a whole music industry in such a manner.

5. Conclusion

As the field of artificial reality expands, the more I learn, and the more I feel like a beginner. It is my conviction that organic paradigms can offer some startling new territory for an artist to explore. More than anything, such an approach allows the artist to step back from his or her traditional role as God/Creator to become instead a farmer or maybe even a hunter of aesthetic experience. Finally, I hope that artificial biologies somehow allow us to better understand and appreciate the complexity and fragility of the natural world. Such an appreciation would go hand in hand with an aesthetic based on systems and processes rather than simply objects and images. It is my belief that, when exposed to the artistic products of this kind of aesthetic, people may be led to value more the things they now exploit and discard.

References

1 Levy, Steven Artificial Life – A Report From The Frontier Where Computers Meet Biology 1992 Vintage Books New York Paperback edition (pp3-4, 6, 7, 168)

2 The Huron Workstation by Lake D.S.P. is an example of such a system, http://www.lakedsp.com