Real-Time Additive Synthesis Controlled by a Mixture of Neural-Networks and Direct Manipulation of Physical and Perceptual Attributes

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Abstract

We proprose an analysis-based additive synthesis system composed of a RISC processor computing a large number of oscillators and a mixed control structure consisting of neural-networks and more direct mechanisms for the manipulation of defined physical and perceptual properties of musical sounds. This synthesis engine serves a controlling computer connected to it via a dedicated Ethernet over which the Music Parameter Description Language (MPDL) (McMillen, Wessel, & Wright 1994) is used to specify a real-time stream of data.

Previous ICMC presentations have described some of the basic mechanisms used in this system. These are the HTM real-time synthesis server system (Freed 92), an inverse FFT synthesis method (Freed, Rodet, & Depalle 1993), and a real-time neural-network control system (Lee & Wessel 1992). The real interest of this system is the full integration of these elements, their extensive refinement and development, and the addition of a new network protocol, MPDL, for the specification and control of musical events. Furthermore, we have ways to mix neural-network control stategies with mechanisms for the more direct manipulation of physical characteristics like damping, exponential decay, partial comodulation, etc. and perceptual variables like loudness, brightness, roughness, etc.

Our system provides the accuracy of sampling with the extensive control of parametric sound synthesis. Multilayer perceptrons are trained with backpropagation learning on analysis data from large sets of sampled tones laid out in a timbre space that runs across dimensions of pitch, loudness, and articulation (Wessel, Bristow, & Settel 1987). This use of neural-networks not only provides for an enormous reduction in the amount of data required to synthesize a large variety of sounds but also provides a musically meaningful control scheme that compensates naturally for pitch, dynamics, and articulation. This timbral reference control scheme provided by the networks is complemented with a more direct manipulation mechanisms for physical and perceptually-based variables.

The controlling computer is a Machintosh running the Opcode version of the MAX programming environment with special objects that construct MPDL messages to be sent over a dedicated Ethernet to the SGI-based additive synthesis server. Also of interest here is the division of labor between the additive synthesis engine, its control by a large number of amplitudes and frequencies for the oscillators, and the use of a musically expressive high level parameter specification.

(cont.)

References

Freed, A. "Tools for Rapid Prototyping of Music Sound Synthesis Algorithms and Control Strategies" Proceedings of the 18th International Computer Music Conference 1992, International Computer Music Association, 1992.

Freed, A., Rodet, X., Depalle, P. "Synthesis and Control of Hundreds of Sinusoidal Partials on a Desktop Computer without Custom Hardware" Proceedings of the 19th International Computer Music Conference 1993, International Computer Music Association, 1993.

McMillen, K., Wessel, D. & Wright 1994 ZIPI - Proposal for a New Networking Interface for Electronic Musical Devices Available upon request from Zeta Music Systems, 2230 Livingston St. Oakland, CA 94606

Lee, M. & Wessel, D. "Connectionist Models for Real-Time Control of Synthesis and Compositional Algorithms", Proceedings of the 18th International Computer Music Conference 1992, International Computer Music Association, 1992.

Wessel, D., Bristow, D., & Settel, Z. 1987 " Control of phrasing and articulation in synthesis". Paper presented at ICMC, 1987, University of Illinois, Urbana. Proceedings of the International Computer Music Conference 1987, International Computer Music Association, 1987.

(This paper will be provided as addenda upon receipt. (editor))