Center for New Music and Audio Technologies (CNMAT) Studio Report

Richard Andrews

CNMAT, UC Berkeley, 1750 Arch St., Berkeley, CA 94709

richard@cnmat.berkeley.edu, www.cnmat.berkeley.edu

Abstract

The Center for New Music and Audio Technologies (CNMAT) is an interdisciplinary research center within the UC Berkeley Department of Music. CNMAT's programs in education, research, and composition are guided by a commitment to innovation in live music performance, human/computer interaction, and improvisational expression. The Center experienced a substantial increase in concert presentations this past year, many of which featured technologies created by our research team.

1. Introduction

CNMAT was established in 1989 to provide a common ground for various academic disciplines at UC Berkeley (music, computer science, electrical and mechanical engineering, psychology, statistics, etc.) to pursue research, offer educational opportunities, and present new works. The central theme of music technology, combined with the interdisciplinary energy driving our projects, serves to attract scholars and professionals from the local, national, and international communities.

2. Facilities

This year the computer lab for *Music 158: Musical Applications of Computers and Related Technologies* was relocated to a 35-workstation site on campus, allowing us to offer more lab access to our students while freeing up critically needed workstations within CNMAT for research projects and graduate student use. In addition, two hardware labs were recently created within CNMAT to assemble and test research prototypes.

3. Composition and Performance

CNMAT supported an ambitious list of concerts and other presentations this year:

3.1 CNMAT and the Berkeley Symphony Orchestra

CNMAT provided technical support for two major concerts this year with the Berkeley Symphony Orchestra, conducted by Kent Nagano. One concert featured Kaija Saariaho's *NoaNoa* for flute and interactive electronics with Frederick Lau, flute. Another event featured George Benjamin's *Antara*. Both concerts were under the technical direction of David Wessel, with assistance from Matthew Wright and Ali Momeni.

3.2 Shafqat Ali Khan/David Wessel/Matthew Wright

Longtime musical collaborators Shafqat Ali Khan (vocals), David Wessel (interactive computer instrumentation), and Matthew Wright (interactive computer instrumentation) presented an evening of improvisation and interaction.

3.3 Abbie Conant

This concert by trombonist Abbie Conant included works by Chris Brown, Pauline Oliveros, Maggi Payne, Jorge Boehringer, William Osborne, and Alex Potts. The evening also featured the world premiere of *Garden of Earthly Delights*, for trombone and interactive electronics, by Abbie Conant and Matthew Wright, interactive electronics.

3.4 CCRMA/CNMAT Exchange Concerts 2000

A co-presentation of a four-concert series with Stanford's Center for Computer Research in Music & Acoustics (CCRMA), this year's Exchange offered works composed and/or performed by by Bruce Bennett, Chris Burns, Matthew Burtner, Edmund Campion, Chris Chafe, Ching-Wen Chao, Amar Chaudhary, Cem Duruoz, Kris Falk, Matt Ingalls, Chris Jones, Damian Keller, Seny Lee, Hugh Livingston, Silvia Matheus, Ketty Nez, Charles Nichols, Juan Reyes, and Michael Zbyszynski.

3.5 John Schott, Will Bernard

Two concerts were presented featuring Will Bernard, guitar, and John Schott, guitar with Matthew Wright, interactive electronics and technical assistant Ahm Lee. The presentations showcased new hexaphonic guitar effects developed at CNMAT under a research project funded by Gibson Guitar Corp. and the University of California Digital Media Innovation Program (DiMI).

3.6 TEMPO: The Berkeley Festival of New Performance

Planning has begun on a new performance project for June, 2001 entitled TEMPO: The Berkeley Festival of New Performance. This series of concerts, workshops, and panels (funded by the National Endowment for the Arts, the Phaedrus Foundation, and the UC Berkeley Consortium for the Arts) will be presented every other year and will emphasize the presentation of works that involve technology.

3.7 New Pieces by Edmund Campion

METRONOME: This large scale multi-media permanent art work, located at Union Square and 14th Street in New York, features a Meyer sound system projecting sounds chosen and played by Max/MSP. Matthew Wright was the Max/MSP programmer for the project. Another new work, *Ellipsis* (piano, chorus, and electronic sounds) was created for a museum installation at the P.S. 1 Contemporary Art Center in New York. The exhibition, entitled Volume - an exhibition of sound, was curated by Alanna Heiss and Elliott Sharp.

based designs to this project. The first design implements a standard MIDI-interface for receiving, synchronizing and transmitting MIDI messages. The second design uses the CORDIC algorithm for the implementation of a digital oscillator for additive synthesis. The CORDIC-algorithm is described and implemented for three architectures: bit-parallel iterative, bit-parallel unrolled (purely combinatorial and pipelined) and bit-serial iterative. The implementation of the control parameters for the oscillator presents the use of the CORDIC architecture for computing a sine function and multiplication simultaneously. (Lindlbauer, 1999)

5.2 Musical Applications of New, Multi-axis Guitar String Sensors

We have designed and constructed new, multi-axis magnetic and piezo-electric string transducers, based on combining the outputs from multiple sensing elements that favor certain directions in a processing network that estimates motion in desired, orthogonal directions. (Freed and Isvan, 2000)

5.3 A New Music Keyboard featuring Continuous Key-position Sensing and High-speed Communication Options

We have created a new music keyboard with independent, continuous position sensing capable of communicating gestural nuance available on manual tracker organs, harpsichords and pianos. This new system is built to exploit the true potential of the electronic keyboard as a universal gestural interface for finger/key interactions that is independent of the sound-producing mechanism. It uses optical interruption sensing for each key and hybrid space and time multiplexing to achieve the requisite high scan rates. (Freed and Avizienis, 2000)

5.4 An XML-based SDIF Stream Relationships Language

The Sound Description Interchange Format (SDIF) is becoming the computer music community's standard representation for various kinds of sound descriptions (Schwarz, et al., 2000). SDIF represents all sound descriptions as "streams" of "frames" over time, each frame consisting of "matrices" of numerical or text data. An SDIF file may be an aggregate of 2 or more streams. The SDIF Stream Relationships Language (SDIF-SRL) is a formal language for describing the relationships between streams in an SDIF file. This language uses XML, the Extensible Markup Language, an important new standard for creating structured document types and describing them formally. (Wright, et al., 2000)

5.5 Symmetry Groups of Chord Systems

Salvador Comalada, in residence at CNMAT as a Fulbright post-doctoral scholar, set up the basis for a systematical study of symmetry in harmonic systems. The first stage considered chord systems, where a chord is defined to be a transpositional class of sets having the same cardinality. Mr. Comalada's work shows that chord systems are in one-to-one correspondence with certain mathematical combinatorial structures called cyclic 1-designs, the symmetry group of the chord system being precisely the so-called automorphism group of the design.

5.6 Adding OpenSound Control Support to the SuperCollider Real Time Synthesis Environment

SuperCollider now supports CNMAT's OpenSoundControl (OSC) protocol. OSC's arbitrary hierarchical namespace of controllable parameters supports SuperCollider's ability to build patches with arbitrarily complex control structures. OSC's dynamism allows a dynamically changing SuperCollider patch to update its own OSC address space. OSC's ASCII string and 32-bit integer and float data types allow OSC-addressable features to take parameters in natural units like Hertz rather than an arbitrary mapping.

5.7 Real-Time Audio Signal Processing in Java and Ptolemy II

With the release of the Java 2 Platform SDK, version 1.3, Java now provides an audio API supporting high quality (16 bit, 48 kHz) audio capture, processing, and playback. We use this new audio API to explore the use of Ptolemy II and Java for hard-real-time audio signal processing algorithms. Ptolemy II is software, written in Java, that supports heterogeneous, concurrent modeling and design for embedded systems. We have constructed Ptolemy II and stand-alone Java implementations of a particular algorithm which we consider to be representative of many commonly used audio DSP algorithms.

5.8 New interactive guitar effects

CNMAT's Guitar Innovation Group (GIG) developed new interactive effects processing environments for the electric guitar, resulting in the previously mentioned series of concerts featuring guitarists John Schott and Will Bernard. New developments included an extensive real-time sampling and looping environment, pitch and gesture tracking, utilization of CNMAT's sound spatialization theater with surround-sound effects, and hexaphonic application of nonlinear distortion, ring modulation, pitch shifting, tremolo, and other effects.

5.9 Vector base amplitude panning

Vector base amplitude panning (VBAP) is a new amplitude panning method which can be used to position virtual sound sources using arbitrary loudspeaker configurations. Ville Pulkki implemented VBAP in Max/MSP during his residency at CNMAT. (Pulkki, 1997, Pulkki, 2000)

5.11 Research by Steve Coleman at CNMAT

Saxophonist and composer Steve Coleman joined the University of California, Berkeley as an Associate Profesor of Music and musical researcher at CNMAT in January of 2000. His research at CNMAT includes extensions of his work *Ramses*, which was first presented at Ircam's *Agora* festival in June of 1999. This work centered on compositional and performance modeling of rhythm and both the linear and vertical organization of the pitch material. His modeling of rhythmic structures was carried out in the Max/MSP environment and is influenced by two sources: theory and analysis of African drumming by Willi Anku (Anku, 2000) and the rhythmic structure of Carnatic music. This research will be applied in his group's performances in CNMAT's TEMPO festival to be held in June of 2001.

5.12 Gestural input devices

Tactex Controls (www.tactex.com) has developed a multipoint pressure sensitive gestural input device. CNMAT has developed Max/MSP objects that service the Tactex pads. In addition to the basic Max object that brings in a pixel-like array of pressure measurements from the surface of pad, we have developed Max objects that locate individual finger locations and pressures.

5.13 An Open Architecture for Real-time Music Software

Amar Chaudhary has continued to develop the Open Sound World (OSW) environment which has become the topic of his doctoral dissertation. One of the features of OSW is its ability to throttle computational complexity so that hard real time service can be maintained in the face of an unexpected burst of demands on the processor. Chaudhary has developed methods for the on-the-fly or dynamic thinning of additive synthesis data. (Chaudhary, et al., 2000)

6. Personnel

Richard Felciano, Founder; David Wessel, Director; Adrian Freed, Research Director; Matthew Wright, Musical Systems Designer; Edmund Campion, Composer-in-Residence; Steve Coleman, Associate Professor, Music; Richard Andrews, Associate Director.

CNMAT's list of researchers includes Rimas Avizienis, Amar Chaudhary, Salvador Comalada, Richard Dudas, Ahm Lee, Norbert Lindlbauer, Dominique Richard (Richard, 2000), Ron Smith, Takahiko Suzuki, and Brian Vogel. Steve Hoffman is CNMAT's Administrative Asistant. Our roster of graduate student composers includes Keeril Makan, Ali Momeni, Alan Tormey, Dmitri Tymoczko, and Michael Zbyszynski. The list of invited composer/performers includes Georg Graewe, Hugh Livingston, Silvia Matheus, and Ketty Nez.

7. Acknowledgements

CNMAT gratefully acknowledges the support of our corporate sponsors and Industrial Affiliates Program members, including Gibson Musical Instruments, Grace Design, Silicon Graphics, Apple Computer, Meyer Sound Laboratories, Wacom Technology Corporation, Digidesign, Earthworks, Kurzweil/Young Chang, Octiv, and Tom Austin/Sherman Clay. We would also like to acknowledge the support of the National Endowment for the Arts, the Phaedrus Foundation, the UC Berkeley Consortium for the Arts, and Prof. Edward A. Lee of the UC Berkeley Department of Electrical Engineering and Computer Sciences.

8. References

W. Anku (2000), "Circles and Time: A Theory of Structural Organization of Rhythm in African Music" http://smt.ucsb.edu/mto/issues/mto.00.6.1/mto.00.6.1.anku_essay.html

A. Chaudhary and A. Freed (1999), "Visualization, Editing and Spatialization of Timbral Resources using the OSE Framework," presented at Audio Engineering Society 107th Convention.

A. Chaudhary, A. Freed, and M. Wright (1999), "An Open Architecture for Real-Time Audio Processing Software," presented at Audio Engineering Society 107th Convention.

A. Chaudhary, A. Freed, and M. Wright (2000), "An Open Architecture for Real-time Music Software," presented at International Computer Music Conference, Berlin, Germany.

A. Freed (1999), "Bidirectional AES/EBU Digital Audio and Remote Power over a Single Cable," presented at Audio Engineering Society 107th Convention.

A. Freed and R. Avizienis (2000), "A New Music Keyboard featuring Continuous Key-position Sensing and High-speed Communication Options," presented at International Computer Music Conference, Berlin, Germany.

A. Freed, R. Avizienis, and T. Suzuki (2000), "Scalable Connectivity Processor for Computer Music Performance Systems," presented at International Computer Music Conference, Berlin, Germany.

A. Freed and O. Isvan (2000), "Musical Applications of New, Multi-axis Guitar String Sensors," presented at International Computer Music Conference, Berlin, Germany.

N. Lindlbauer (1999), "Application of FPGA's to Musical Gesture Communication and Processing" http://cnmat.CNMAT.Berkeley.EDU/~norbert/thesis.html

V. Pulkki (1997), "Virtual sound source positioning using vector base amplitude panning," *Journal of the Audio Engineering Society*, vol. 45, num. 6, pp. 456-66.

V. Pulkki (2000), "Generic Panning Tools for MAX/MSP," presented at International Computer Music Conference, Berlin, Germany.

D. Richard (2000), "Music as HandWerk, the middle way between Vorhandenheit and Zuhandenheit," presented at International Computer Music Conference, Berlin, Germany.

D. Schwarz, X. Rodet, and M. Wright (2000), "Extensions and Applications of the SDIF Sound Description Interchange Format," presented at International Computer Music Conference, Berlin, Germany.

M. Wright, A. Chaudhary, A. Freed, S. Khoury, and D. Wessel (1999), "Audio Applications of the Sound Description Interchange Format Standard," presented at Audio Engineering Society 107th Convention.

M. Wright, A. Chaudhary, A. Freed, S. Khoury, and D. Wessel (2000), "An XML-based SDIF Stream Relationships Language," presented at International Computer Music Conference, Berlin, Germany.