Audio Sequencers and Sound Activated Graphics in Networking

As a research scientist, my work involves developing art environments for CAVE Automated Virtual Environment (CAVE) theaters. CAVE theaters are room-size displays made up of three to six walls. A CAVE has a rear-screen projection system, tracking system, stereo sound system, and a graphics-intensive computer system. These components offer a CAVE system or a CAVE-like display of stereo graphics and audio, a wide field of view, user-centered perspective, graphical updates in real time, and first person interaction. These elements enhance the CAVE participants' sense of immersion and in turn their actions. By being situated in a wide field of view with action inputs, the participant is immersed in an action-reaction loop where the computer is tracking both the display and the participants' actions. This feedback loop makes it difficult to determine where the interactions begin and end.

My research also involves using high-performance networks that are faster than ordinary networks. A consortium of universities, laboratories, and research centers around the world has laid down elaborate network structures initially called the Internet2 and now referred to as "the Grid." Portions of this network have been fortified with fiber optics running on lambda grids. These sophisticated protocols have tested at 250 times faster than the regular Internet. A testbed of experiments occurred last September and included science, medicine, engineering and art applications. The conference called iGrid 2002 occurred at the University of Amsterdam's SARA Computing and Networking Services. The event connected the high-speed fiber optic protocols of each country together: Holland's "Netherlight" with the USA's "Starlight." The international Grid network structure is the "iGrid," scientists are said to be "grid computing" and communicating with one another "via the Access Grid."

by Margaret Dolinsky

The iGrid

And if you are wondering why we need the iGrid, the website explains: "As computational scientists strive to better understand very complex systems -- whether biological, environmental, atmospheric, geological or physics, from the micro to the macro level, in both time and space -- they will require petascale computing, exabyte storage and terabit networks. A petaflop is one-hundred-times faster than today's largest parallel computers, which process ten trillion floating-point operations per second (10 teraflops). An exabyte is a billion gigabytes of storage, and terabit networks will eventually transmit data at one trillion bits per second -- some 20 million times faster than a dialup 56K Internet connection." (http://www.igrid2002.org)

In other words, the Grid establishes service standards using modern computing architecture. Recently, networked applications were multi-cast and information was simultaneously broadcast over networks to multiple sites. Currently, by using the Grid, service is comprised of distributed objects with specific input and output messages. In effect, rather than receiving multi-cast information, an object would receive the input most necessary to its goals. These goals include data analysis, sensor management, visualization and simulation that requires super-fast high-speed networks to do massive numbers of calculations per second and send the information to research nodes. The research nodes would then collect or display the data results

in the appropriate fashion.
The International Grid, or iGrid, is advantageous to my work because I network audio inputs in real time. Audio has the most latency during network distribution. You may notice audio lagging, for example, when TV news anchors are attempting to communicate with persons on the space shuttle or with news reporters in remote areas.

"Beat Box"

At iGrid 2002, I showcased a sound art environment called 'Beat Box.' 'Beat Box' presents networked CAVE participants with a playful arena of interactive virtual sound machines. Each of the sound machines has a unique periodic duration and controls, respectively, tones (notes), ambient loops, bass sounds and drums. The machines are comprised of a row of odd heads that represent a distinct interval in the scale and contribute to the resultant voice of the collective instrument. Each head grows during its time interval and calls out a sound designated by the participants. As the participant changes the sound designation on a head, the head changes its voice. The rows of heads produce a sense of presence by creating a unique sound effect. All together, the sound machines live on their land where there is no Julian or Gregorian calendar, no leap year or Farmer's almanac. Time can only be measured by the head calling out at a sequence in time on sonic machines that bear the date of synchronized input and of interaction updates. 'Beat Box' is a virtual sonic chronometry as it keeps time with the sound based on user interaction.

Networking CAVEs across the Grid

CAVE-to-CAVE art is creating shared experience. Each remote location has a tracked participant that is represented by a unique avatar. The avatar moves with each tracked participant who can control the location of the body, hand(s) and head depending on the number of tracking sensors. The avatars of participants become a part of the artwork. It is not like telepresence, which bridges a gap in space. It is more a stream of consciousness movement and the experience is a bridge between discrete consciousnesses.

Beat Box
Bass Sound Sequencer

In an effort to build art applications that exploit a stream of consciousness movement, one must concentrate on psychological components of human nature and visualize the elements of uncertainty, recognition, choice, transformation and emergence. I am interested in creating experience in virtual reality using metaphors that play on various levels of our consciousness. I use space, color, image, and the element of surprise to invoke a feeling -- where one has to gasp or catch a breath -- in order to hold the vision and its potential meaning at bay. CAVE virtual reality by its structural nature of the display theater is a fertile ground for wonderment.

Entering a space and being tethered to a computer establishes a level of awe as well as performance anxiety. I am constantly asking myself how to employ, enhance, and manipulate the participants' involvement in order to connect them with the artwork. I also ask how they might like to play in a software environment and how to exploit the structure and hardware of the CAVE environment towards those ends.

I see the artwork 'Beat Box' as a cerebral toy in which one is thinking and playing in the cube with the building blocks of art, science, architecture, and the psyche. Arts coupled with technologies alter the way we can experience the world because the interactions in the CAVE can augment vision and intensify emotion. The CAVE is well suited for exploration in worlds of the imagination because it can provide a sensory experience rather than a rational confrontation with real life objects. The experience -- or immersion -- is enhanced through participants' interactions, which results in the direct manipulation of the visuals, audio and sensory level, in effect, the environment.

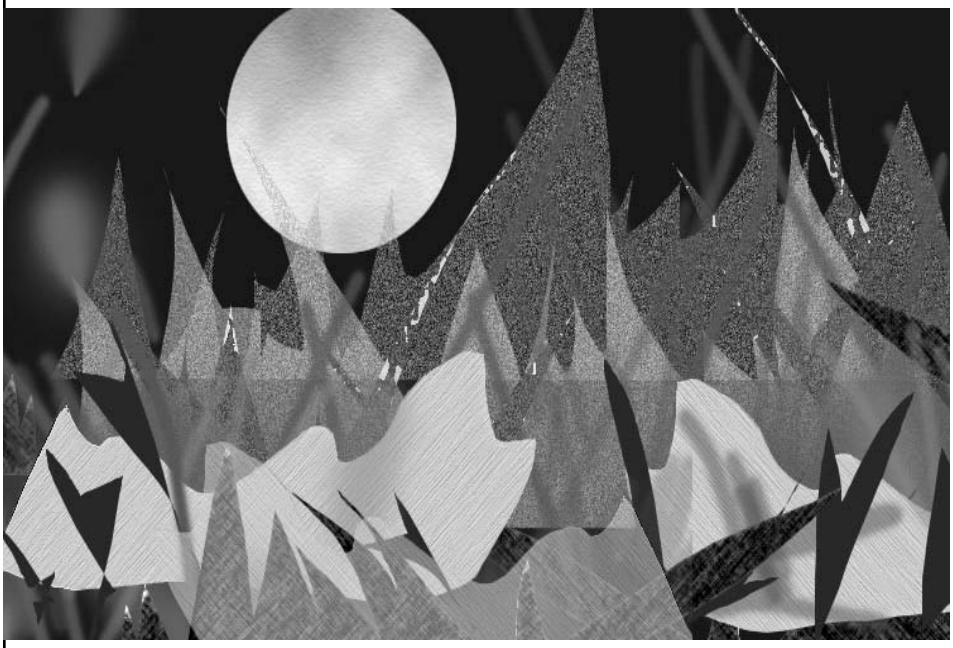
The environment consists of drum sets and three sound machines representing, respectively, percussion, ambient, and bass sounds. Each set of these instruments is placed on large round areas hov-

ering above the land. The bright landscape is an outdoor scene of abstract vegetation. Obscure heads represent each interval of the sound machines or sequencers. The heads expand one at a time, sequentially across the sound machine to indicate which time interval in the sequence is currently active. As participants set sound selections to an interval (essentially one of the heads), the head is given a voice and sounds out a particular audio file.

Directions for participants

The interaction in the 'Beat Box' environment is not trivial. In a stand-alone situation, it is easy to have a different type of controller such as a trackball with complete detailed instructions. In the CAVE scene, just beyond the entrance, is a large sign. The sign contains instructions and images of the environment. Simple large text displays:

"Button2 sets a sound selection"
"Button2 sets and unsets the sound at an interval"



"Button2 here resets the scene to silence"

Beat Box Environment

The artist has to consider that the circumstances of being in a CAVE are fairly novel and that instructions for CAVE environments are not uniform for all artworks. Everyone who steps into an unfamiliar scene has a level of performance anxiety. I tend to accommodate a variety of styles of users, from novices to expert gamers. The novices have a chance to vector about and play with the 3D qualities of the objects and the CAVE's projection qualities. Musical aficionados or folks who prefer a challenge can learn to activate the sounds and have an impact on the environment. Those who like to be shown everything can be satisfied as well: CAVE-to-CAVE networking is an advantage in complex environments because the networked participants can ask questions as well as guide one another through their avatars.

Avatars

The participants running the tracking sensors are the show. They control the environment and the events that occur across the network. More aptly, it is the avatars that dominate the field with their movements across the scene, their head and hand gestures and the voice that emanates from them. It is amazing how alive the avatar becomes with the sound of a voice. One truly feels in communication with someone who has control of a representation of themself as the avatar takes on the personality of the voice behind it. In a large group exhibition with CAVEs all over the world, so many things are occurring at each venue that there is no real way to know exactly how many people are out there, what their time of day or the mood at each site is Typically one person, usually the most gregarious, leads the pack in adventure and conversation.

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Collaborative Performance

High-speed networking is important for collaborative performances of 'Beat Box.' The artwork depends on the synchronization of sounds between the activated machines and the corresponding graphical updates. 'Beat Box'

was run previously on the Internet2 during the Ars Electronica Festival in 2001 between multiple remote sites. The network would experience some lag when the number of sites participating rose above three. The lag became increasingly significant with the addition of each site. The greatest number of connecting sites at one time was seven. As each site was added, the artwork became incoherent, with the audio and data drop out getting worse and worse. These losses were not as visible with the iGrid in 2002. The synchronization between the sounds, machines, and graphical updates was smooth and satisfying between five sites.

Conclusion

The design of the environment, the participant controls and the potential for dynamics between participants becomes a timing issue in a global phenomenon. Most rewarding was the fact that musicians and persons with an understanding of time and sound were particularly playful with the sound machines. Most persons delighted in the variety of selections, from simple percussion sounds to techno-industrial rhythms. 'Beat Box' works well with a gregarious person who is either familiar with a sequencer's concepts or is interested in engagement with virtual machines and developing an understanding of how the environment functions.

Note: Non-Networked Collaborative Performance

Surprisingly enough, a single user can run the artwork as well. 'Beat Box' was displayed at the Indiana University Art Museum as a stand-alone exhibition that anyone was free to interact with when the museum was open. Instructions and polarizing glasses were provided next to a track ball on a podium. The display system, called a John E. Box after its designer John N. Huffman at Indiana University, sat on a 40"x50" table positioned four feet in front of a module. John E. Box is a viable alternative for exhibiting stereo graphics and real time environments without a tracking sensor. The display is bright and has good color saturation. As a result, the lighting does not need to be dark and is able to show along with other paintings, photography, and ceramics. This low cost, fully contained unit was also easy to turn on and off at the beginning and close of each museum day with one simple switch.

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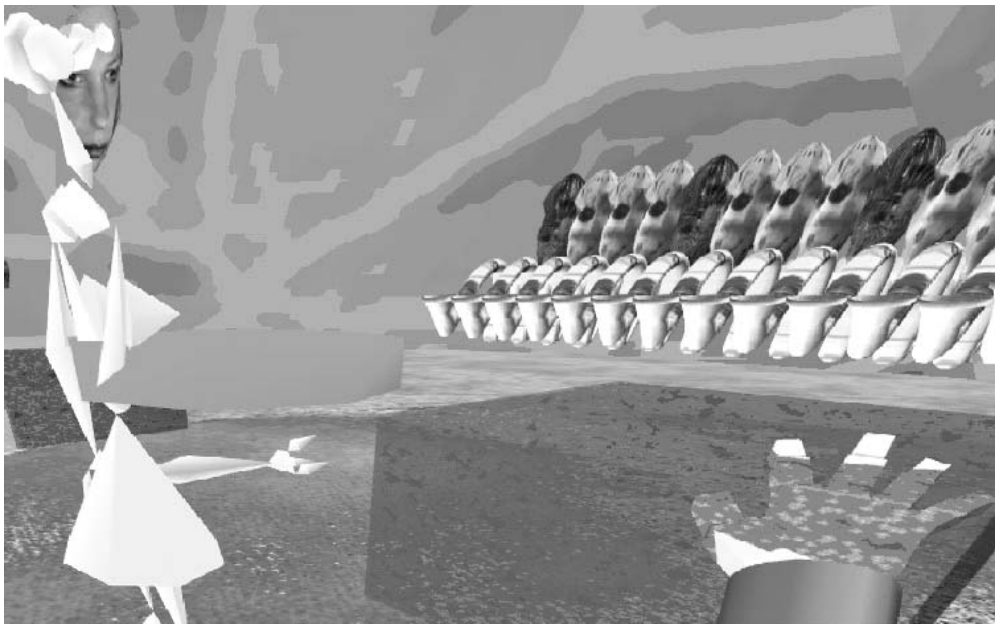

Avatars performing Beat Box