The Artist/Engineer Collaboration

What was the first musical instrument? We may never know the answer, but we do know that music is much older than recorded history — earliest archeological musical instrument specimens go back 30,000 years or more. Primitive early musical instruments were more discoveries than inventions, but for thousands of years they have evolved to what we now know as modern instruments. Have musical instruments stopped evolving? Highly unlikely — if anything, the pace has increased.

During the course of human history until this century, all music was played acoustically, and thus it was always physically evident how the sound was produced. The player controlled the sound directly by playing (eg, plucking, blowing, striking) the instrument, and the performer’s gestures were directly translated by the instrument into sound. This direct physical relationship started to become indirect in recent centuries; with keyboard instruments, the piano and the organ both have some kind of mechanism between the player’s fingers and the sound.

In the 20th century, the invention of electronic musical instruments has seen a “decoupling” between the performer and the resulting sound. This has led to a “decoupling” between the performer’s gestures and the resulting sound. This has led to new types of “intelligent” musical instruments where the contemporary performing artist uses technology to create innovative new compositions, performances and improvisations. One such new instrument is the radio drum, whose development is being refined through collaborative research among faculty and graduate students of Music and Engineering at the University of Victoria.

The Radio Drum Explained

The radio drum was first developed at Bell Laboratories in the mid 1980s as a three-dimensional mouse, which failed as a computer peripheral and instead became a musical instrument. A kind of “virtual instrument,” it is a descendant of the theremin, the amazing musical instrument invented in 1917 that generates sound in response to hand movements in free space within an electromagnetic field.

The radio drum works on a similar principle: the drum itself does not produce any sound. As a gesture sensor, like the theremin, it detects the performer’s movements to trigger and control sound, but the performer does not have to physically touch any surface to create a sound. The radio drum consists of two parts: a rectangular surface (drum) with embedded antennae and two transmitters embedded in conventional sticks that use different radio frequencies. The drum surface is covered with a layer of foam to provide a quiet, elastic playing surface and to avoid striking the circuit board. The radio tracking technique depends on the electrical capacitance between the radio transmission antenna in the end of each stick and the array of receiving antennas in the drum. The drum generates six separate analog signals that represent the x, y, z position of each stick versus time t. A key attribute of the radio drum is the multidimensional nature of the gestural signal. This is in contrast with unidimensional controllers such as keyboards, which have velocity sensitivity only.

Components of New Musical Instruments

In order to consider musical performance with new musical instruments such as the radio drum, three components are required:

- a gesture sensor that detects the performer’s movements and responds to them by creating control signals;
- a sound engine that generates sounds according to a sound synthesis model with parameters; and
- control algorithms that map the control signals into the parameters of the sound synthesizer.

The performer therefore controls the sound via gestures, and the range of expression is determined by the complexity available in each of the above three components.

Fully decoupling the gesture from the sound (and putting a computer in between) creates enormous possibilities. The instrument can now do anything as a result of the gesture, which can trigger and control any sound (not only drum sounds). The gesture can also control image and video displays, or any other device that can be controlled via an electronic input signal.

One could say that the mechanism (or “action”) in the conventional piano, strings and soundboard have now become electronic circuits, chips and computers. Sound generation is now accomplished via computer chip and nothing vibrates except the loudspeaker at the end of the chain. This allows the creation of totally new sounds — sounds that would be impossible to replicate physically. Examples are playing 88 notes at once on a piano, dividing the octave into microsteps to create new timbres (character of sounds) with spectra unknown in acoustic music, etc.

These open possibilities are very exhilarating artistically. However, an equally important issue arises: how do you play these new electronic/computer instruments? In other words, even if we can make these wonderful new sounds, how will we control and perform them?

The Performance Question

Early electronic music did not worry so much about performance; early works from the mid 20th century were often
The subtle and nuanced motions we make while playing a musical instrument relate closely to what and how we intend to represent music in real time. Sound synthesis techniques have also improved significantly in recent years. Engineers and artists are in the process of creating new musical instruments and new methods of timbral expression. The radio drum is one such instrument that has evolved to incorporate the gestures of the performer in a more musical way, and applying it to a high-level control of sound. The USDA and the University of Victoria. His research interests include: radio communications, audio/video signal processing and interdisciplinary work. His website is www.radiodrum.com. The authors acknowledge financial support for this project from the Natural Sciences and Engineering Research Council and the Canada Council for the Arts.