Tutorial Proposal for ACHI 2010

Exploring Sensory Substitution Techniques:
    Crossmodal Audio-Tactile displays - Using the skin to hear

Crossmodal displays offer alternative means of experiencing one type of sensory information using a different modality. There has already been a great deal of research into the translation of images onto tactile displays including the Brainport tongue vision system (http://vision.wicab.com/technology/), fingertip braille displays (http://www.cim.mcgill.ca/~vleves/TAP05/2-VBD.php), and more complex tactile vision systems (http://www.esenseproject.org/minimalTVSS.html), however music translations have been primarily focused on the visual senses (http://en.wikipedia.org/wiki/Cymatics), with little attention given to the tactile properties of music.

Because sound is vibration, much of what is detectible through our auditory system is also detectable through the skin. However, the complexity of music and sound in general makes it difficult to interpret as tactile vibrations. Previous research into audio-tactile translations primarily focus on voice translations that present sound as vibrations to the fingertips and arms, as in the vocoder (http://en.wikipedia.org/wiki/Vocoder), which can effectively assist deaf or deaf/blind people in accessing information from speech through the tactile senses.

Unlike voice, music presents significantly more complexity than the voice, posing additional challenges to researchers attempting to make this form of media accessible using the skin. While some have attempted to apply phase shifts and other signal processing algorithms to sound to make it more accessible to the skin, by altering the audio signal, we also alter the tactile signal which can dramatically alter the experience that a user can potentially gain from a more direct interpretation.

One of the main emotional characteristics of music is achieved through the instrumentation, composition, and harmonic features of combination of sounds, which can be lost when the signal is process, and the organic nature of the vibrations are altered.

A different approach would be to include the entire audio signal in the tactile display, but to alter that signal in such as way as to maximize the tactile sensations, with minimal alteration to the original signal. To do this, researchers at Ryerson University have developed the Emoti-Chair, a vibrotactile system that uses voices coils to presents music as multiple, discrete audio signals to the body.

The theory behind the Emoti-Chair is called the model human cochlea (MHC):

this is based on the human cochlea as a metaphor for turning the skin into a hearing organ by delivering sounds to the brain by first breaking the signal down into smaller frequency components that can be processed by individual receptors that can detect the complex signals contained in sound information. Effectively, the MHC can use the skin as a low-resolution cochlea device that distributes sound to multiple locations along the body, towards the potential stimulation of the audio cortex without using the ear.

Tutorial Description

Goal:
To introduce participants to the concept of vibrotactile music, the Emoti-Chair, and the physical characteristics of the skin that make it possible to feel music.

Outline:
Our proposed tutorial will run for three hours, beginning with the introduction of the Emoti-Chair as a research tool for facilitation and creation of vibrotactile music. This will take place in the first ½ hour of the tutorial, when participants will have to chance to examine the system and try it for themselves.

Next, we will discuss and explain the basic theory behind the MHC system, addressing topics that influence our ability to feel music, such as the tactile mechanoreceptors stimulated by sound vibrations, a brief discussion about their concentration in different locations on the body, and the limits of what we can feel according to current research. There can then be short break.

At the start of the second hour, we will present the processes involved in translating the music onto the Emoti-Chair, highlighting the many configurable features that can be used to experiment with different ways of presenting sound to the body as vibrations. This will provide participants with the opportunity to examine the software and the hardware used to present the vibrotactile music on the chair, and to be come familiarized with the system, its processes, and capabilities in translating music to vibration during the second half of this hour.

After another short break, we will begin the hands on portion of the tutorial, which will be based on group activities to allow participants to compose and experience tactile music.

In the music composition group, participants will be given a collection of digital and analog musical instruments that they can use to explore the chair and the different types of vibrations that sounds can induce. Participants will also be encouraged to explore the frequency distribution bands, tuning the chair to provide effective translations of different instruments and their signal ranges. We will be using a distributed version of the MHC, which can support eight individuals in working on separate channels of the EmotiChair to create vibrations and sounds that can then be combined to experience a full vibrotactile

composition.

A second group will be given the same type of system, only this time, they can experience existing music through their own ipods or our itunes music library through the MHC. They will be asked to experiment with the different settings on the chair, including frequency distribution, volume, and sounds. Each participant will have the chance to select their own frequency split and try it on different types of music. We will also ask members of the group to experience the vibrations while being deafened using headphones that present different noises we use to mask the audio signal of the chair. This will give everyone the opportunity to experience the system as a deaf person might, offering an important perspective to the potential benefits that the chair can offer people who are deaf.

By the end of the tutorial, all participants will have had the opportunity to learn about sensory substitution of music as touch, to create and experience vibrotactile music, and to gain an understanding of the MHC from first hand exploration of both creating and feeling vibrotactile music.

References:

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