Augmenting Signals Against Noises
Understanding the Human Body with Data Sonification

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aim | background | our projects {movement, brain activities}
Reassurance
Communication
Encouragement
Inspiration
Exploration
Achievement

Positive Emotion
Creating a positive soundscape

Reduce bad sounds (noise)

Promote good sounds (signal)

Good sounds help us:

- feel good
- communicate better
- explore with curiosity
- take good action
Today’s talk

Sonification of muscular activities
• Surface EMG - “muscles in coordination”
• Turning physical therapy engaging and guided
• Blind and aged clients
• Auditory Biofeedback

Sonification of brain activities
• Understanding the statistical characteristics of multi-channel ECoG/EEG signals intuitively
• Synthesizing sounds (esp. in timbre) reflecting the brain activities
Data Sonification

“Sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation.”


“Humans have great auditory acuity when it comes to comparing slightly mismatched things.”

Chafe: An Interview with New Scientist. (2014)
Data Sonification

Classic examples

- Stethoscope
- Heartbeat monitoring (electrocardiogram)
- Geiger-Müller counter
Data Sonification

Modern examples

- **Signal**: “Sonification of Tohoku Earthquake” from Sonifyer project (Florian Dombois et al.) [http://youtu.be/3PJxUPvz9Oo](http://youtu.be/3PJxUPvz9Oo)


- **Model-based**: “Brain Sthetoscope” by Chafe and Parvizi [http://youtu.be/n0T2uB-GLc8](http://youtu.be/n0T2uB-GLc8)
Data Sonification

**Bigger goal: establishing theory/methodology**
- Embed information into sound
- Represent structures/patterns in data with sound
- Sound as a medium for emotional expression

**Technical challenges: dealing with complexity**
- Representing quantitative/dynamic aspects of data
- Representing multidimensional data with timbre
- Integrating multiple sounds in ensemble
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Iguchi et al. “How is auditory EMG biofeedback effective for blind people?” (2013)
Benefit:
No distraction for postures
Playfulness leads to stronger motivation
Turning (often dull) rehabilitation fun

Movement Sonification (Motion Capture)

- Auditory Feedback helps blind people to control better
- Auditory Feedback helps both blind and sighted people to feel confident
- Tracking task: Very little error, no problem for rehabilitation
• 56 channel seizure data (ECoG)
• Channels with similarity “stick together” causing auditory grouping effect

Terasawa et al. “Sonifying ECoG Seizure Data with Overtone Mapping” (2012)
Brain Wave Sonification

- Listening to multi-channel EEG data at once
- With higher correlation in data, its sonification gives more coherent impression
- Single-trial data - possibility for the real-time application

Kaniwa et al. “Electroencephalogram steady state response sonification focusing on the spatial and temporal properties” (2014)
Brain dreams Music" Project
A collaboration with Takayuki Hamano, Takashi Nakagawa, and Kiyoshi Furukawa
Concert Performance at Tokyo university of the Arts (2012)
“Brain dreams Music” Project
A collaboration with Takayuki Hamano, Takashi Nakagawa, and Kiyoshi Furukawa
Installation Version (2014)
Good sounds help us:
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Movement sonification
- makes moving fun
- effectively instructs motion
- assurance and motivation for rehabilitation

Brain wave sonification
- represents statistical characteristics of data
- exhibits “music and brain” relationship
- generates artistic music
- mediates sonic interaction
Future Work

- Multidimensionality and timbre
- Gestalt principles other than grouping
- “Musical” representations

- Movement: Gait biofeedback
- Brain wave: Installation
- Application to cells and insects

Making good sounds to feel good?

- Good sound is not static
- The sonic universe is expanding
- User-centric - yet users keep changing with eye-opening experience relating with sound