Auditory Displays and Sonification

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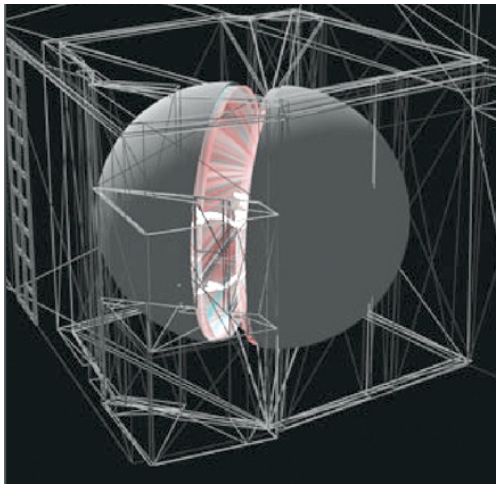
MAT 200C

Auditory Display

- A system that uses sound to convey computer data.
- Geiger Counter

- Allosphere



Auditory Displays

Mini-Allosphere – The US Airforce's ALF

WHY?

Motivation

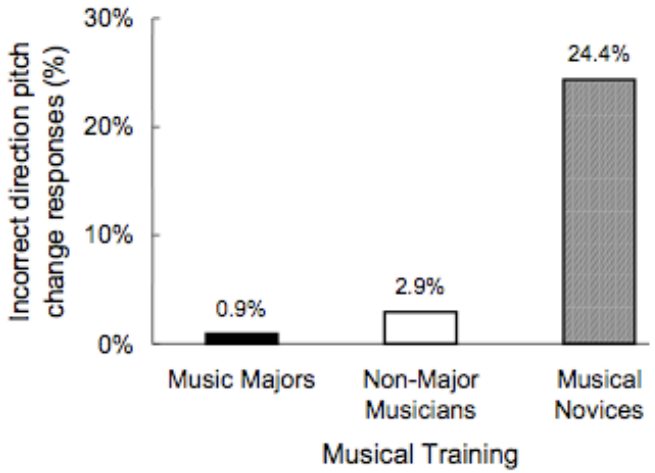
The motivation for using non-speech sound in human-computer interactions is manifold, because:

- Sound represents frequency responses in an instant (as timbral characteristics)
- Sound represents changes over time, naturally
- Sound allows microstructure to be perceived
- Sound rapidly portray large amounts of data
- Sound alerts listeners to events outside their current visual focus
- Sound holistically brings together many channels of information

Adding sonifications to data visualization will be like adding sound to silent films.

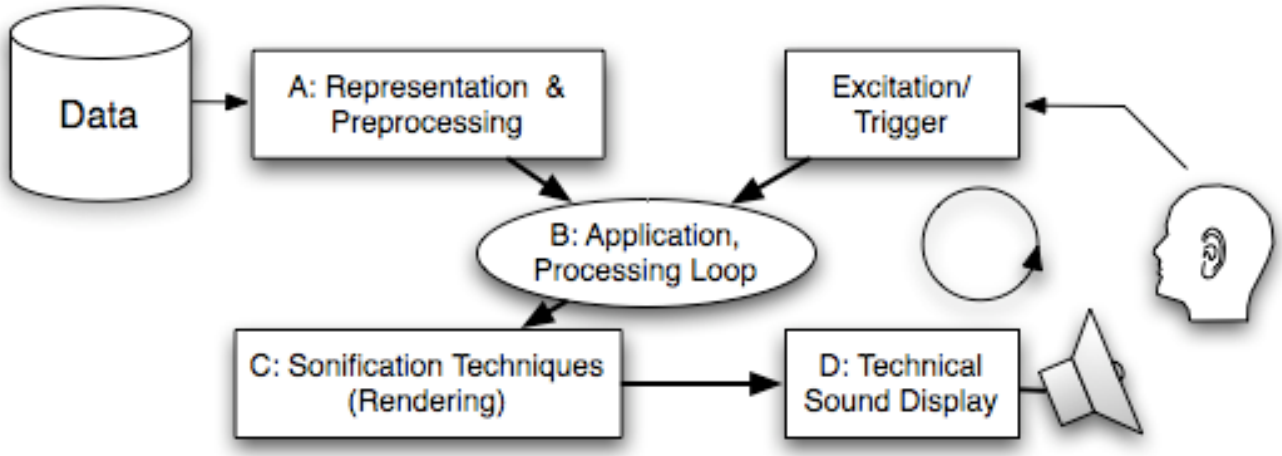
LIMITATIONS

- Interfere with other auditory communication (speech or other AD output)
- Humans are better at remembering abstract visual patterns and shapes than abstract sounds. Musicians tend to do better though.



SONIFICATION

- The processes and algorithms that generate the sound output of auditory displays
- "the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication of interpretation"



SONIFICATION

Definition: Sonification (by Thomas Hermann)

[see ICAD 2008 article (pdf, 340k)] Any technique that uses data as input, and generates (eventually only in response to additional excitation or triggering) sound signals may be called sonification, if and only if

- (A) the sound reflects properties / relations in the input data.
- (B) the transformation is completely systematic.
  This means that there is a **precise** definition of how interactions and data cause the sound to change.
- (C) the sonification is **reproduceable**: given the same data and identical interactions/triggers the resulting sound has to be structurally identical.
- (D) the system can **intentionally** be used with different data, and also be used in repetition with the **same** data.

Sounds in Sonification

- Auditory Icons
- Earcons
- Spearcons (new)

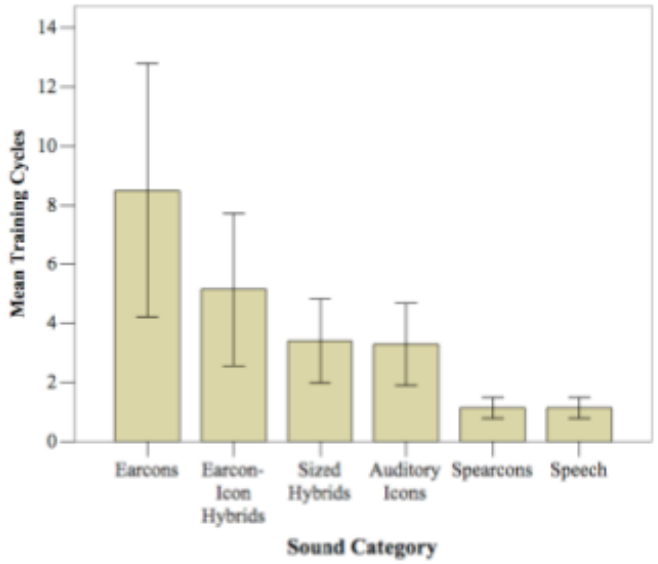


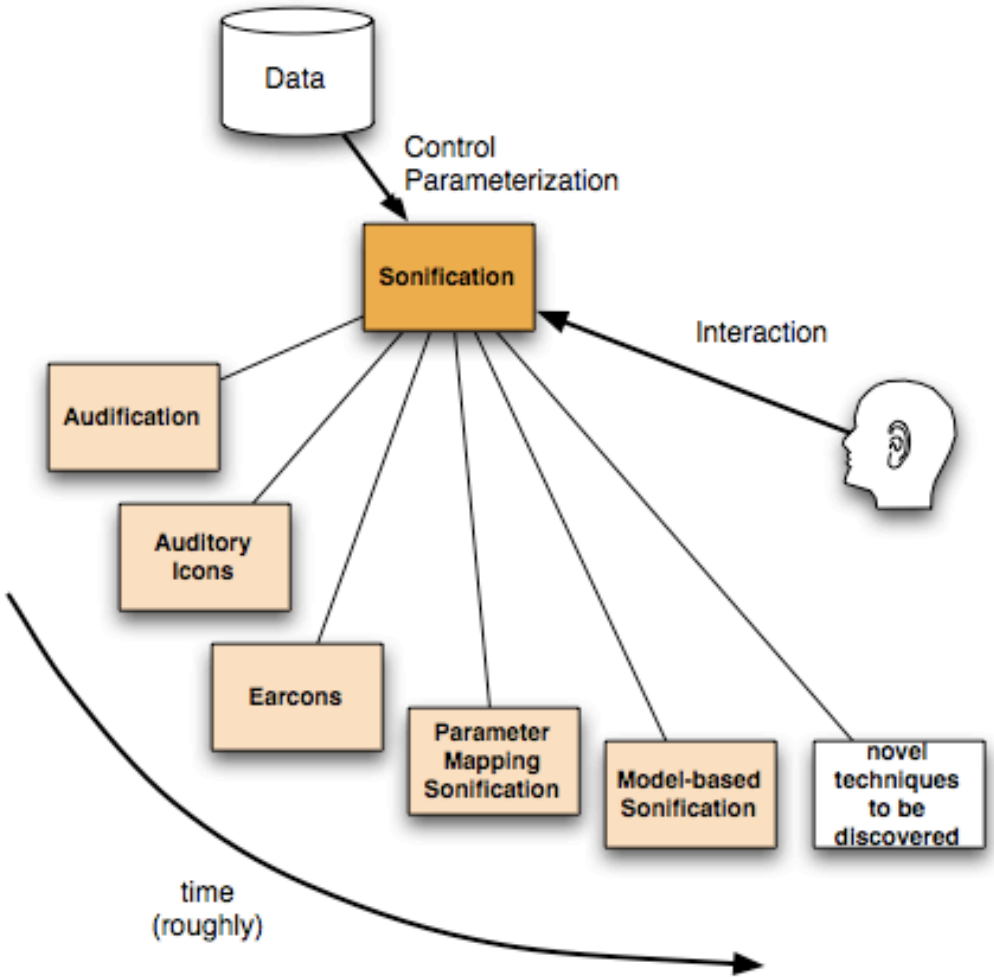
Figure 2. *Mean number of training cycles needed to reach 100% accuracy in a testing phase. The error bars indicate the 95% confidence intervals of the means.*

Types of Sonification

- Iconic
- Direct Conversion (Audification)
- Musical

- Parameter-Mapping
- Model-Based

- Interactivity with biofeedback or parameter adjustment.


Data
Control
Parameterization
Sonification
Interaction
Audification
Auditory
Icons
Earcons
Parameter
Mapping
Sonification
Model-based
Sonification
novel
techniques
to be
discovered
time
(roughly)

Mapping Data to Sound

- Not well defined
- Few formal guidelines
- Mainly an issue of psychology
- => Difficult
- Considering Aesthetics
- => More difficult

- What does data sound like?

Parameters of Sound

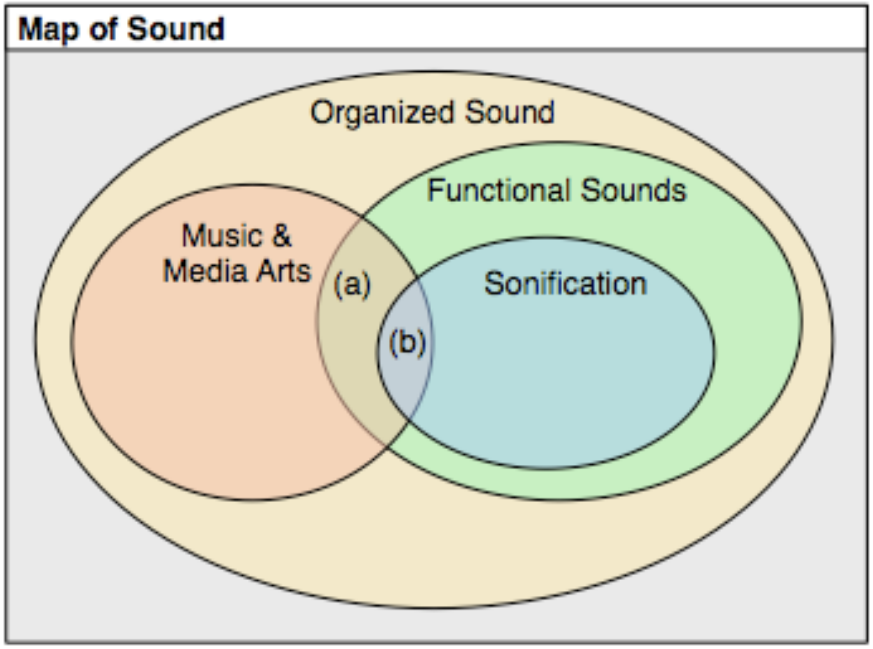
- 8 fundamental characteristics of a waveform by JoAnn Kuchera-Morin: frequency, amplitude, phase, envelope, spectrum, shape, velocity, wavelength
- Synthesis parameters: FM, AM, Additive, Grainular, etc
- Musical Parameters: tempo, tuning, etc
- Spatial Parameters: sound position in space

APPLICTIONS

- Process Monitoring
- Exploratory Data Analysis
- Art/Music
- Human-Computer Interfaces
- Artificial Vision: vOICe => artificial synesthesia

Discussion: Is it Music?

- Music - “an artistic form of auditory communication incorporating instrumental or vocal tones in a structured and continuous manner”
- Is sonification a valid form of music? When can we call it music?
- Do we need to define “pleasing music”



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Kramer, G. (1994a). An introduction to auditory display. In G. Kramer (Ed.), Auditory display: Sonification, audMA: Addison Wesley.

Thomas Hermann, TAXONOMY AND DEFINITIONS FOR SONIFICATION AND AUDITORY DISPLAY (Proceedings of ICAD 2008)

Tilman Dingler1, Jeffrey Lindsay2, Bruce N. Walker, LEARNABILTIY OF SOUND CUES FOR ENVIRONMENTAL FEATURES: AUDITORY ICONS, EARCONS, SPEARCONS, AND SPEECH, Proceedings of the 14th International Conference on Auditory Display, Paris, France, June 24-27, 2008

Thomas Hermann's research on Sonification, Data Mining & Ambient Intelligence, http://www.sonification.de