Sonification Concept Proposal
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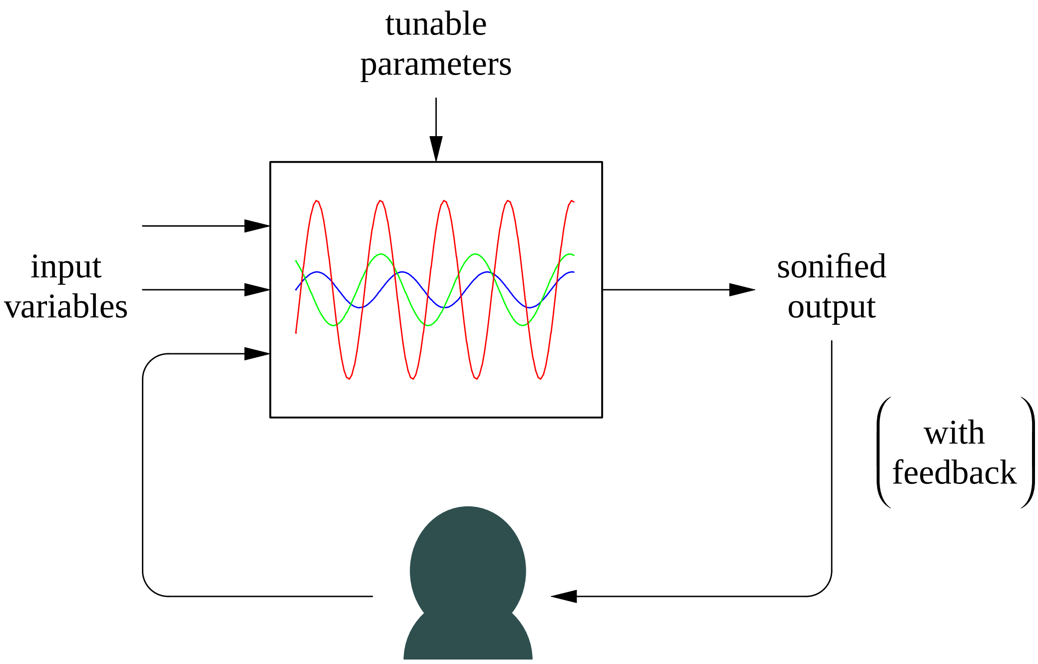
Overview

Sonification can essentially be defined as *'the technique of rendering sound in response to data and interactions'* (Hermann, Hunt and Neuhoff, 2011). The field of Auditory Display, of which sonification is a core component, aims to develop human-machine interfaces which rely on the human auditory system as the primary interface channel. The considerable power of human hearing has been largely underused and underappreciated in the development of conventional machine interfaces. Auditory feedback is often included merely as an afterthought, or simply to ornament visual features with pleasing sounds.

There are some very useful aspects of our sense of hearing which provide significant advantages over that of vision. A classic example is the ease with which our ears can discern the various parts of a large collection of acoustic sources, such as in an orchestra. Bregman (1990) theorised that this was achieved by the processes of *grouping* and *streaming*. In nature, sounds which emanate from the same source are likely to share common characteristics, so-called *grouping cues*. These can include the timing of the sounds, if they are perfectly synchronous they are likely to be coming from the same source. We may also group frequencies based on their harmonic relationship, those that share a common fundamental frequency are likely products of the very same source. By grouping these sounds a single source can be identified, and by tracking any common changes over time we can mentally represent this source as an auditory stream. It is by this mechanism that we may discern the orchestra, a single instrument, or the person talking in the row behind us.

An understanding of the way our brain processes and extracts information from sounds, known as psychoacoustics, is essential to the design of auditory display interfaces. The behaviour described by Bregman, which he calls Auditory Scene Analysis, gives an indication of how one may integrate many discrete auditory streams to achieve the information bandwidth necessary to compete with well-established visual displays.



Key Design Elements

As described earlier, the capabilities of the human ear to discern and distinguish various qualities of sound are sophisticated and have long been useful. They are not however, infallible. Extensive research has been undertaken to determine the general characteristics and limitations of our hearing. For instance, the smallest perceivable changes with respect to frequency (Moore, 2013) and duration (Plomp, 1964) and how they vary across a range of frequencies and loudness levels. While still impressive, they do impose an upper limit on the capabilities of our ears, limits which must be allowed to inform the design of any auditory display.

Carlile (2011) observes that ‘*in the complexity of real world listening, many factors will contribute to the perception of individual sound sources.*’ He goes on to describe these sound sources as perceptual objects, and highlights the importance of understanding ‘*how variations in the physical properties of the sound will affect different perceptual objects.*’

While it may be due to our overfamiliarity with conventional visual displays and the relative infancy of sonified feedback, I feel that sonification plays upon a primal, innate intuition far more than other commonplace interfaces. In light of this, I feel we must look more deeply into how and why auditory stimuli affect us in the way they do, in order to take full advantage of the powerful sensory awareness that has been cultivated over uncountable ages.

As is often the case, it is by observing nature that we find a path forward in the design of these new technological systems.

Sonification Use Cases

Time Management Application

Living under the seemingly perpetual shadow of the COVID-19 pandemic, remote working has become a significant portion of many of our lives. For me, the most persistent challenge brought on by this new (and yet too familiar) environment is to keep focused on the task at hand, and not to be led astray by the many distractions lurking in most of our homes.

I aim to make use of one of the most pervasive aspects of sonification, an awareness of time and of our passage through it. All too often I find that a ten minute coffee break has degenerated into an hour of aimless wandering, spending my time neither well nor enjoyably.

In order to sonify our perception of time, in particular to enforce the consumption of a short break, I propose to implement a timer which gradually increases in frequency and grows more assertive as the designated time expires.

The goal is to suggest a passive but persistent awareness of time as it passes, with the gradual build up hopefully impressing upon the user the increasing need to return to their task, as opposed to a simple alarm which is silenced and quickly forgotten.

The particular parameters are a subject of further research, they may ultimately be user-defined or there may be optimal values supported by psychoacoustic findings. The simplicity of the application makes hardware requirements of little consideration, the best implementation would likely be for a smartphone or similar device.

Rhythmic Dictation Tool

In transcribing music, perhaps the most difficult part lies in determining how long a note is, and when exactly it occurs. Compounding this problem, if one is transcribing a piece it is very likely implied that they have no reference with which to compare. Technology offers a possible solution with the use of scorewriter programs, a user can input their best guess and have it played back to them to determine if they are right. However, installing an entire music notation suite seems to me an overly complicated way of achieving this.

Using a microcontroller such as the BBC micro:bit with onboard motion sensors, one could directly input their desired rhythm simply by shaking the board. Assuming an accurate implementation, this would not only provide a more natural interface but an absolutely correct representation of the desired rhythm.

Extending this idea, musical information could be loaded onto the board and played back to the user to provide a reference. The user would have the opportunity to train against this rhythm, attempting to synchronise to the beat in a way that has been proven time and time again in countless sonification projects (e.g. The Soundbike. Maes, Lorenzoni and Six, 2019).

References

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