NEW DIRECTIONS FOR SONIFICATION OF EXPRESSIVE MOVEMENT IN MUSIC

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ABSTRACT

Expert musical performance is rich with movements that facilitate performance accuracy and expressive communication. As in sports or rehabilitation, these movements can be sonified for analysis or to provide realtime feedback to the performer. Expressive movement is different however in that movements are not strictly goal-oriented and highly idiosyncratic. Drawing upon insights from the literature, this paper argues that for expressive movement in music, sonifications should be evaluated based upon their capacity to convey information that is relevant to visual perception and the relationship of movement, performer and music. Benefits of the synchronous presentation of sonification and music are identified, and examples of this display type are provided.

1. SONIFICATION OF EXPRESSIVE MOVEMENT

Recent developments in auditory display have infused human motion with sound for the purpose of analysis, motor learning, and adapted physical activity [1]. However, human motion is not limited to goal oriented movements like those frequently found in sports. In music for example, *expressive* [2] or *ancillary* [3, 4] gestures refer to movements that are not responsible for sound production, but nevertheless common in performance. Though complex and diverse – varying with the instrument, performer, and musical piece – these movements are otherwise highly consistent over time and reflect musical structure and expressive intention [5].

The use of high-resolution motion capture systems has enabled the quantitative study of these movements. In a typical setting, a performer wears reflective markers that are tracked overtime in three spatial dimensions using an array of calibrated infrared cameras. Due to the size and complexity of the data sets, sonification can be used to quickly browse through the data, make non-obvious relationships more apparent, and facilitate the process of data analysis.

1.1. Previous Work

The use of sonification for studying expressive gesture in performance began with a study of four clarinetists [6] who were asked to play the same piece of music with exaggerated, normal, and immobilized playing modes. Though mapping choices were discernible and could be used to expose data relationships that were not visually obvious, the mapping was not easily extendible to other performers due to the high variability in the movement patterns between subjects.

A more recent work [7] has compared Principle Component Analysis (PCA) and velocity of markers as preprocessing steps for sonification in a bimodal context using a "stickman" visualization. Using an open task, they found that sonification would work well in directing the attention of the user to aspects of the visual display in the velocity based mapping, but not in the PCA.

2. A NEW METHODOLOGY

Gesture in music performance is a rich field for sonification, but the expressive nature of these movements warrants special consideration that is distinct from goal-oriented movements that are common in sports. What is more important than the exact positions or velocities of points and angles on the body are the "higher-level" structural and emotional information they carry. This information can be organized around the relationship of movement performer and music, and what the movements convey to the viewer.

2.1. The relationship of movement, performer, and music

Building upon a foundational work in the study of expressive movement [4], there are three levels of gestures that need to be conveyed in sonification, the *material, structural,* and *interpretive*. Material gestures are those that are defined by the instrument being played. For example, the cello is more limited in possible expressive movements than the clarinet, resulting in different movement patterns. For a good sonification, a listener should be able to identify this type of difference.

The structural level of gesture concerns the relationship to the underlying music. For instance, highly difficult passages of music often impede mobility while easy passages and phrase boundaries see an increase in movement [8]. Though each performer moves differently, these sorts of structural cues are important and should be clear in sonification.

Finally, the interpretive gestures concern the performer's unique interpretation of the piece and convey their structural and emotional representation. For a good sonification, a listener should be able to identify two "takes" of the same performer playing a piece of music and likewise perceive that a different performer has played.

2.2. The perception of movement in musical performance

In the perception of music, the visual context provides cues that can modulate the emotional and structural perception of a piece. For instance, simply viewing a performer can extend the perceived length of phrases and reduce or augment ratings of tension [8]. In another study, [9] showed that the visual perception of regularity, fluency, speed, and amount of motion could predict the emotional ratings of happiness, sadness, and anger.

Results of [9] supported a possible invariance between viewing conditions, instrument, and musician. This invariance was supported by [10], who modificatied stickman avatars derived from motion capture data of real performers. Completely immobilizing the arms or torso, or even playing the avatar in reverse did not significantly effect judgements of tension, intensity, fluency, or professionalism. Increasing the amplitude of motion of the whole body was important however, implying this factor was more important than the movement of individual body regions.

If factors such as amplitude of motion are indeed more important to visual perception than the exact part of the body being moved, than it is wise that sonification of performers prioritize this cue. Additionally, if the regularity, fluency, and speed are important cues for conveyed emotion, likewise sonifications should focus on the ability to correctly display this information.

3. SONIFICATION FOR MUSIC-DATA ANALYSIS

New music research abounds with large, complex, time-varying data sets. For this data, sonification as a tool for analysis or display benefits from the shared medium of music and sonification. For gesture in particular, some of these benefits have already been identified by researchers using interactive sonification to teach bowing technique of the violin.

The first benefit, identified by [11], stressed that the shared temporal nature of music and the data could be used to understand data events as they occur temporally relative to the music. Later, [12] identified that for sonification and music research, listening is a familiar and widely used medium. Also, the shared acoustic medium could provide a more direct access to relationship of data and performance audio. For expressive gesture, this may provide a fuller display of the performer's expressive intension than the music alone, and may be closer to the performer's internal representation of the structural and emotional content of the piece.

A benefit that has not yet been identified is that through sonification, the visual aspect of musical performance is made accessible to the blind (or those who cannot see). If a sonification design is able to convey the structral and emotional cues discussed in Section 2, then it is a display medium that can be used to make expressive gesture accessible through sound.

Videos hosted on the IDMIL website[1] and Vimeo[2] provide examples of this display type. In the first example, a performer's expressive gestures are sonified and presented with performance audio and video. In the second example, sonification of the "eigenmodes" of a subject dancing to music [13] displays four metrical layers that can be compared to the metrical layers of the music itself. In both of these examples, sonification provides a dynamic display that conveys non-obvious information as well as the performer's unique representation of the piece.

4. CONCLUSIONS AND FUTURE WORK

This article has argued that for sonification, expressive movement should be treated differently than goal-oriented movement. Evaluation should be based upon the ability to convey movement cues that are relevant to visual perception and that highlight the relationship of instrument, music, and performer. Pairing music and sonification has benefits for analysis and display that are unique to their shared medium. In this way, a successful sonification can make expressive gesture accessible and provides a more complete display of a performer's expressive intentions in the same medium as the performed music.

[1] www.idmil.org/projects/sonification_project

[2] www.vimeo.com/peto/videos

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