Direct Solo Piano Sonography

Thomas Davidson

University of Cambridge - Corpus Christi College
tjd45

12th March 2019

Abstract

Through a performance of Nikolai Rimsky-Korsakov's (1844-1908) 'Song of India' I present a novel musical visualisation approach which generates live sonograms based on direct input from a MIDI-keyboard. I build on established principles of the connection between auditory and visual cues and attempt to incorporate this with a measure of tonal distance.

Performance Details

Date - Tuesday 12th March, 2019
Venue - LT1, William Gates Building
Description - A visualisation of solo piano music using a self-written Java program to generate live imagery based on MIDI input. The visualisation utilises the JFugue[1] library as well as awt[2] and Swing[3].
Performance Piece - Song of India
Performance Composer - Nikolai Rimsky-Korsakov
Performer - Thomas James Davidson, Masters student in Computer Science, studying at Corpus Christi College - University of Cambridge. Thomas has a keen interest in research within Computer Science, specifically in the use of novel visualisation techniques to allow for further interrogation of artistic and literary works. His other work includes attempts to visualise classic literature as well as various data analytics projects. Aside from his studies, Thomas' artistic output also includes photography (work currently on exhibition in Queens' College) as well as piano and vocal performance.

Introduction

Analysing and understanding a piece of music in real-time often requires an established knowledge of musical theory as well as a trained ear[1]. This can make appreciating tonal melody throughout a piece an exclusionary activity. Through the development of my new visualisation tool I hope to make this accessible to a wider range of people whilst also creating an aesthetically pleasing and artistic representation of the piece.

Sonograms

I use sonograms here to refer to a representation of the keys pressed on a piano (rather than representation of audible frequencies). The sonograms I eventually generated dynamically change depending on the keys pressed as well as the velocity with which they are played. I laid out a grid to represent a full 88-key piano, such that the bottom left corner represented the lowest note playable on the keyboard (A0) and the top right corner the highest (C8). This representation allows for repetitive patterns throughout the image especially when chords are played, regardless of what key the chord is in.

[1] http://www.jfugue.org
[2] https://docs.oracle.com/javase/7/docs/api/java/awt
[3] https://docs.oracle.com/javase/7/docs/api/javax/swing

Tonal Distance

Note	Ranking	Colour
C	Triad - Root	
G	Triad - 2	
E	Triad - 3	
B	In-Key - 1	
A	In-Key - 2	
D	In-Key - 3	
F	In-Key - 4	
Bb	Out-Key - 1	
Eb	Out-Key - 2	
G#	Out-Key - 3	
C#	Out-Key - 4	
F#	Out-Key - 5	

Tonal Distance Colour Rankings

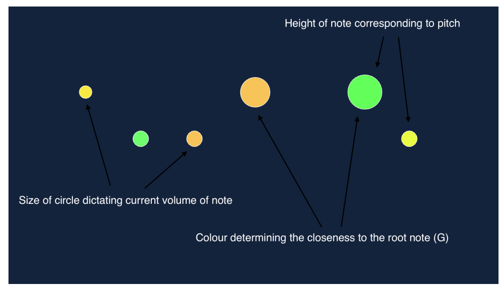
I build on previous research into tonal distance to establish a metric for how ‘close’ two notes are[2]. In a more formal system I would carry out extensive experimentation to ensure the objectivity of this metric, but for the purposes of this performance and investigation it suffices. The measure I have utilised is potentially subjective, but the nature of the design of the system makes it very easy to substitute a more rigorously tested or a more fitting colour scheme for artistic purposes, for example.

Auditory-Visual Cues

My visualisation utilises links between auditory and visual cues through volume (circle size), pitch (spatial position), and through the tonal distance of notes from the key root (colour, see above section). By building on previous research[3][4][5][6] which has found the interpretation of most of these cues to be inherent for a viewer, I believe that I have created a visualisation which makes the analysis of a piece of music far more accessible.

Song of India

The piece I have chosen to perform is an orchestral piece taken from an opera (Sadko) and arranged for piano. It is very suitable for this visualisation approach as it is almost entirely set in the key of G major and throughout the piece incorporates use of out-of-key notes as well as chromatic runs which lead to attention catching acoustic elements which are well translated into the visual space.



A labelled screenshot of the final system

Applications

As I discussed in my research proposal essay I believe this tool has many potential applications, especially for use in music teaching. In particular in the use of music as an interventionary teaching tool for children suffering from autism spectrum disorder, where verbal interaction has often shown to not be as effective as visual or multimodal interaction[7][8][9][10][11][12].

This is a very powerful tool for music teaching in general as it allows for users to exploratively learn by discovering combinations they like, or by comparing their performance of pieces to recorded pieces, with the benefit of easy to match visual stimuli rather than the more unfamiliar auditory stimuli that learners normally have to rely on. Moreover, it can also be used by experienced musicians to develop their own interpretations of pieces and to help with improvisations.

This tool also has many applications in a purely artistic sense allowing performers to portray other areas of the music which are not immediately apparent from the pure audial experience. For example, by using the visualisation as an effective dynamic score it is possible to exactly translate how the piece is being played (such as when a note is held down rather than the sustain pedal being used).

References

[1] Kathleen A Corrigall and Laurel J Trainor. Effects of musical training on key and harmony perception. *Annals of the New York Academy of Sciences*, 1169(1):164–168, 2009.

[2] W Bas De Haas, Remco C Veltkamp, and Frans Wiering. Tonal pitch step distance: a similarity measure for chord progressions. In *ISMIR*, pages 51–56, 2008.

[3] Tom Collins, Sebastian Böck, Florian Krebs, and Gerhard Widmer. Bridging the audio-symbolic gap: The discovery of repeated note content directly from polyphonic music audio. In *Audio Engineering Society Conference: 53rd International Conference: Semantic Audio*. Audio Engineering Society, 2014.

[4] Scott D Lipscomb and Eugene M Kim. Perceived match between visual parameters and auditory correlates: an experimental multimedia investigation. In *Proceedings of the 8th International Conference on Music Perception and Cognition*, pages 72–75, 2004.

[5] Kostas Giannakis. A comparative evaluation of auditory-visual mappings for sound visualisation. *Organised Sound*, 11(3):297–307, 2006.

[6] Kostas Giannakis and Matt Smith. Imaging soundscapes: Identifying cognitive associations between auditory and visual dimensions. *Musical Imagery*, pages 161–179, 2001.

[7] Jennifer Whipple. Music in intervention for children and adolescents with autism: A meta-analysis. *Journal of music therapy*, 41(2):90–106, 2004.

[8] Kathryn E Ringland, Rodrigo Zalapa, Megan Neal, Lizbeth Escobedo, Monica Tentori, and Gillian R Hayes. Sensorypaint: a multimodal sensory intervention for children with neurodevelopmental disorders. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, pages 873–884. ACM, 2014.

[9] Lilia Villafuerte, Milena Markova, and Sergi Jorda. Acquisition of social abilities through musical tangible user interface: children with autism spectrum condition and the reactable. In *CHI'12 Extended Abstracts on Human Factors in Computing Systems*, pages 745–760. ACM, 2012.

[10] Anjana Narayan Bhat and Sudha Srinivasan. A review of ?music and movement? therapies for children with autism: embodied interventions for multisystem development. *Frontiers in integrative neuroscience*, 7:22, 2013.

[11] Gustavo Schulz Gattino, Rudimar dos Santos Riesgo, Dânae Longo, Júlio César Loguercio Leite, and Lavina Schüler Faccini. Effects of relational music therapy on communication of children with autism: a randomized controlled study. *Nordic Journal of Music Therapy*, 20(2):142–154, 2011.

[12] Laura Schreibman, Geraldine Dawson, Aubyn C Stahmer, Rebecca Landa, Sally J Rogers, Gail G McGee, Connie Kasari, Brooke Ingersoll, Ann P Kaiser, Yvonne Bruinsma, et al. Naturalistic developmental behavioral interventions: Empirically validated treatments for autism spectrum disorder. *Journal of autism and developmental disorders*, 45(8):2411–2428, 2015.