

Musical Compositions and Algorithms of Force Feedback Systems

This research report will present and reflect on some outcomes regarding the use of open-source force-feedback interfaces in musical, compositional and performance context. Two musical compositions have been realised and performed by the author using low-cost haptic devices using motorised faders called FireFader developed by Edgar Berdahl and the author¹. Both compositions have been realised with the Open Source Haptics for Artists OSHA framework² and their technical implementation required the design and programming of a series of haptic models in Max programming language. Additionally, the first composition required the reconfiguration and redesign of the FireFader mechanical part by using digital fabrication techniques. Both composition try to express the qualities of haptic interaction importance of coupling of the hand with the underlying musical process.

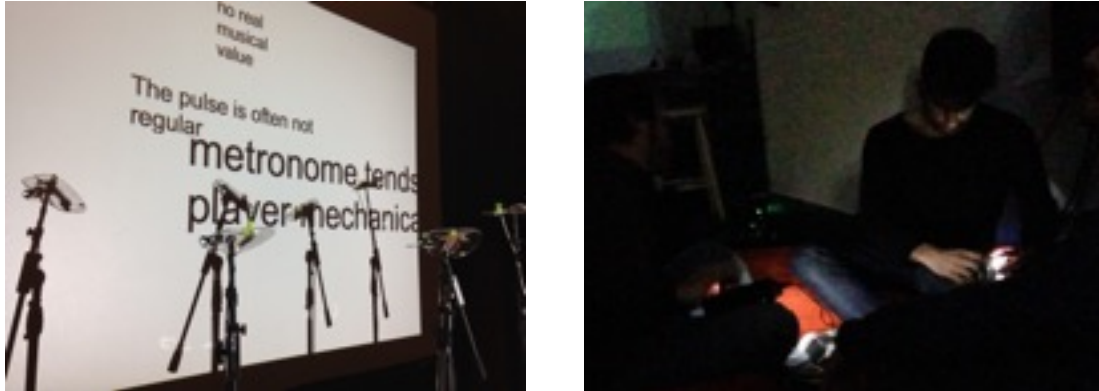


Figure 1: Left Metronom, Right Mechanical Entanglement

Metronom

Metronom, which stands for metronome in Welsh, is a live audiovisual composition for a custom designed haptic interface. The interface which was co-designed with Olivia Kotsifa, consist of four haptic faders, and a digitally fabricated transparent acrylic structure, etched and cut according to the requirements of the music and the visual content. The performer interacts haptically with the moving faders, which behave like metronomes, at various tempi and rhythmic motifs. The faders' mechanical sounds are recorded and processed in real-time by digital signal processing algorithms and projected sonically back into space. Moreover the positions of the faders, driven by automated procedures and altered mechanically by the performer gestures, are controlling various compositional parameters affecting the timbre, the rhythm and the movement of various projected words and phrases. A gradual interplay between the shadows of the physical interface's structure, the human gestures and the light refraction from the acrylic surfaces shapes equally the visual elements of the composition. The present inter-media performance, is an interactive audio-visual composition and a dance between the hands of the performer and the movements of the haptic interface. The sequenced force signals that move the faders are mixed with the forces applied by the performer and create a semi-automated music performance. The performer can manually control the range of the oscillations, their equilibrium point and affect the motion of the moving faders. This mechanical shared control over the music content offers new interesting possibilities in interactive composition.

Mechanical Entanglement

Mechanical Entanglement is a musical composition-improvisation for three performers, composed and programmed by the author, George Sioros and Odysseus Kleisouras. Three haptic devices each containing two haptic faders are mutually coupled between them using virtual linear springs and dampers. During the composition, the performers feel each other's gestures and collaboratively process the music material. The physical modelling parameters of the interaction are modified during the five sections of the composition. A time-stretching algorithm, developed specifically to simultaneously process three stereo channels, is stretching in an out-of-sync- three copies of the same music clip. The performers are playing with the stretching algorithm and an amplitude modulation effect which are both mapped to the haptic physical model and are applied to recognisable classical and contemporary music compositions. Each of them is substantially time stretching the same music clip and simultaneously affects subtly or often abruptly the gestural behaviour of the other performers. At various points in the composition, the music becomes gradually in sync and the performers realign their gestures. This phasing "game" between gestures and sound, creates tension and emphasises the physicality of the performance. The modelling coefficients often take values impossible to occur in nature such as negative damping between the interaction of the performers, thus creating very unfamiliar interaction sensation. Moreover, instabilities that occur due to the long feedback control delays makes the gestural and sonic dialogue very difficult and quite often unpredictable.

¹ Berdahl, E., Kontogeorgakopoulos, A., 2013. The firefader: Simple, open-source, and reconfigurable haptic force feedback for musicians. *Computer Music Journal* 37, 23–34.

² <https://github.com/eberdahl/Open-Source-Haptics-For-Artists>