ConDiS – Conducting Digital System

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Abstract

This paper presents the Conducting Digital System - ConDiS a conducting glove, designed to enable a conductor not only to control the overall sound of the performing musicians but also to control a digitally processed version of the performer´s sound in real time. It allows the conductor to "grab" a *digitally processed* sound from one or more instrument, change its volume, sonority and move it around the hall, all in real time, with his/her conducting gestures. In this way, the conductor also becomes composer and fellow performer.

In other words, conducting the overall balance/volume, timbre and location in space between the instrumental signal and the computer-generated sound signal. ConDiS is directed toward new possibilities in musical composition and the interaction, the expressions, the musical gestures and movements of the classical conductor.

Are we capable of building a system that feels "natural" both for the musical composition and the conductor? Can we build a gesture recognizing system that allows the conductor to use his/her natural way of expressive conducting, to add the same expressiveness to live interactive electronic sounds? Through analyzing conducting gestures, testing various sensor techniques and most importantly, composing music, the ConDiS project will seek answers to these questions.

Keywords

Artistic Research, Music Technology, Music Performance, Conducting, Composing.

Introduction

In his book, The Computer Music tutorial (1996) Curtis Roads wrote:

"The original remote controller for music is the conductor's baton".

But what if we were to take the remote control and develop it even further? To develop a system where the conductor can with physical body movements or gestures, remotely control the acoustic sound and at the same time the sonic spectrum and timbre of digitally processed sound of the same acoustic sound?

As the technology for Human-Computer Interaction (HCI) keeps evolving interactive systems are more and more capable of analyzing and recognizing human body movements and gestures. This opens a floodgate of possibilities to integrate the orchestral conductor´s capacity to control the overall flow of the "whole" musical performance. Instead of having a sound engineer in the middle of the hall triggering and mixing the digital sounds to the analogue sounds of the orchestra, the conductor now for the first time has the opportunity to extend his/her conducting expressions and interpretation in an unmediated way.

Through ConDiS the conductor also becomes a performer. Not only does his/her role change, the whole form of live interactive performance

also becomes more directly visible and audible. In this way, the complete audience and performance experience is transformed.

The goal of this artistic research is to develop a new system or conducting tool for a musical conductor that is based on and adds on to the tradition of classical conducting. To build such a system, it is essential to understand the conductor's role in historical perspective. This entails respecting the priority of the conducting job (Johannsen & Nakra,Schuller & ebrary Inc., 1998, p. 268) and understanding the meaning and force of the conductor´s gestures and expressions, body, hand, face, eyes – interpreting them, as it were.

The art of Conducting

The conductor is by definition a person who stands center stage in front of performing musicians, and whose conduction of musical measures is realized by a flow of organized hand and at times whole body movements which draw specific patterns in a 3D space around the conductor. These movement patterns are periodic and may be grouped into different sets of beats".(Rodrigo Schramm, Feb. 2015)
The conductor´s job is to realize and interpret the music and to do so he or she expects all those before him to be subject and subordinated to him.

Without making any sound the conductor uses his body language, arm, hand and finger gestures, facial expressions, anger, smile, eye contact, everything that can be summed up as musical gestures. The conductor interprets a composition through a written musical score, including all necessary information about the performance, pitch, timbre, tempo, rhythm and volume of any of the performing instruments. (Johannsen & Nakra,Godøy & Leman, 2010, p. 268) The ideal conductor must learn the music by forehand, must get it in his neurological system and then he must be able to express this emotion to his performers, first by words at rehearsals and then by his musical gestures at the concert. Therefore one can conclude that "in terms of conducting, as a trained motor skill used for nonverbal communication, effective gestural cues are vital".(Peter Visentin, 2010)

Conducting tools

In the eighteenth century, the conductor´s baton was introduced as a tool to help make clearer gestures for the orchestra to follow. By extending the arm of the conductor the ever-increasing demand for larger stage performances the conductor baton made it easier for the performers to physically watch or see the conductor's gestures. With the establishment of conducting schools in the mid nineteenth century gestural patterns or "rules" evolved for all metric indication such as 2/4, ¾, 4/4 and 6/8. Other musical gestures accepted generally used for musical expression are small gestures for less volume (pianissimo) or larger gestures for more volume, stiff conducting gestures for strict rhythmic playing (staccato gesture) and more curved or soft gestures for more melodic playing (legato).

With the complexity of twentieth century compositions not only did the harmonic language of music explode but also the orchestra form. Contemporary experimental composers preferred smaller instrumental ensembles and different instrumental combination where the tiniest details of the written score could be illustrated through the conductor's gestures. As a consequence, more twentieth century contemporary music conductors preferred to use their hands rather than the baton. This way they had more control in their "fingertips" to implement the smallest details of the music. It is interesting and should be kept in mind that there has been very little development of conducting tools other than to stop using the only tool that has been developed for conducting, the conductor´s baton.

With these historic perspectives in mind the ConDiS project focuses on developing a new conducting tool that is itself a consequence of the historical evolution of the art of conducting. During the research process,

the fundamental question of this project is constantly raised **"Are we capable of building up a system that feels "natural" for both the musical composition and conductor?"**

Development of the ConDiS conducting system

The first idea was, unsurprisingly, to think historically. What if one were to make a pole that could be used similarly to Lully´s conducting pole? A romantic and intriguing idea, perhaps, but much too limiting and somewhat unnatural for the conductor. The second idea was more practical and more in the spirit of Curtis Road idea quoted earlier, namely that the conductor's baton was to become the original remote. A prototype was made of a conducting baton that contained a sensor in the shaft. It was initially thought desirable that a mere technological upgrade of the traditional baton would be the answer. After testing the baton, and recording various gestural patterns, this was found to be too limiting and constraining for the conductor. Distinguishing between the conducting of the orchestra and/or the computer-generated sound signal proved too challenging, as did switching between various means of controlling of the electronic sound groups etc. The ultimate solution was that favoured by so many of the conductors of contemporary music: the ConDiS conducting tool was placed right at the conductor´s "fingertips" or even better in his/her hands, via the conducting glove the "ConGlove".

Technological issues

Since the ConDiS research project is aimed towards artistic rather than technical research this paper will confine itself to only brief mention of some important fundamental technical decisions made during the development of ConDiS, the Conducting Digital System.

Choice of hardware

The fundamental decision to make ConDiS a conducting glove "The ConGlove" was to some extent disappointing, since there had been high hopes to create something totally "new". There are dozens of digital gloves available, many used in virtual reality environments and video but some also to directly control audio, such as Imogen Heap's "Mi.Mu" Glove. The unique element of the ConDiS project is to create or preserve continuity with the traditions of classical conducting, thereby utilizing the conductor´s existing skills. Therefore, it was concluded that the most "natural" addition is to bring the digital control right to the conductor's fingertips.

Choice of sensor

A greater range of sensors is now available than ever before, at ever more affordable prices, and in constant evolution
To select which type of sensor would best suit the idea of the Conducting Digital System the following criteria were proposed: it needed to use wireless technology, which is simple to use but complex enough to fulfill its function; to be reliable, meaning it would not be affected by external interference such as infrared lights or human sweat, to be comfortable and natural for the conductor to wear and finally low cost. The following sensors were tested: The Leap Motion Controller, The Myo Gesture Control Armband, The Hot Hand, The Qualisys Motion Capture Systems, Xbox One Kinect 2.0 Sensor and the x-io Technologies, x-OSC sensor.

The X- OSC was selected for my Conducting Digital System for the following reasons: (see table)

Brand	Tech. type	Simple/Complex	Reliability	Comfort	Prize
Leap Motion	USB	_	_	+	+
Myo Armband	Infrared	+	_	+	+
Hot Hand	Bluetooth	_	+	+	+
Qualisys	Infrared	_	+	+/-	_
Kinect 2.0	Infrared	Not working on Mac	?	+	+
X - OSC	Wi-Fi	+	+	+	+

Choice of software

The ConDiS system is written in Max/MSP object oriented environment and Max for Live. To achieve its artistic aims the decision was made to base the system on Ableton Live, a commercially based, universally available software which is flexible and user friendly. ConDiS is intended to be accessible without hands-on support from the developer. It is intended to be flexible and customizable, an important factor in the artistic philosophy of the ConDiS project

Practical and technical requirements:

The requirements include MacPro with ConDiS and Ableton Live, ConGlove conducting glove, one or more microphones determined by the numbers of performers, min. four speakers (two for stereo demo or headphones) and audio card I/O determined by numbers of performers.

Artistic Research

After substantial effort involved in assembling the software, predominantly working in the Max/MSP environment and the transferring it to M4L and Ableton Live it seems to be running properly, meaning the ConDiS project is getting closer to the results originally aimed for i.e. interactive remote control of computer-generated sound signal.

In the original plan, made at the start of the ConDiS research controllers (parameters)to be controlled by the conductor were categorized as:

1. Overall volume.
2. Spatial location.
3. Sonority and spectral timbre, of the performing musicians and the computer audio.
4. Conducting tempo (tap tempo)
5. Synchronization between conducting score and electronic score.

Although not yet universally attained, these factors have been realized to a significant degree.

1. **Volume control.**

The conductor can raise or lower the overall volume of the sound. He/she can use finger gestures to trigger the volume control feature and then by lifting left arm raise the sound and trigger it off when the sound is at "right" level. The same goes for reducing the volume except the arm must be lowered.

2. **Pan control.**

The conductor can move sound in space. He/she can use finger gestures to trigger the pan control feature and then by tilting the hand, move the particular location of the sound.

3. **Effect control.**

The conductor can raise or lower the overall effect volume. He/she can use finger gestures to trigger the effect control feature and then by lifting or lowering the left arm, raise or lower the sound.

4. **Conducting tempo (tap tempo)**

The conductor changes tempo by clicking a button to reflect the written tempo.

5. **Synchronization**

The conductor can by clicking a button move the electronic score back and forth to selected numbers (practice numbers) written in the score.

The combination of finger, hand or arm gestures seems according to the conductor´s experiential account to be working "relatively naturally" with the proviso that (at least for now) a fully natural experience cannot be achieved when technological hardware is attached to the hands.
Raising and lowering the arm for volume adjustment feels natural, as does tilting the hand left/right or right/left for panning control of spatial location.

It must be emphasized that ConDiS artistic research is focused on the author´s personal needs as a composer, in composing live interactive electro/acoustic music. It is therefore fundamentally based on his preference for writing music using a traditional musical score and conventional composition. Nevertheless, new graphics, and new auxiliary signs, need to be added into the score for the conductor to conduct the electronic score "new" graphics have been added to the score. This is yet to be tested by a professional conductor.

See attached posters for further illustrations and instructions.

Composition

It should be kept in mind that even though the aim of this project is to extend the compositional possibilities and the role of the classical music conductor the emphasis is placed on changing as little as possible of the composer´s writing tradition and conductor traditional gestures. Therefore, the dynamics and duration of notes are notated in the score both for the performer and the electronics, and exist prior to the performance.
What is added in the real time of performance are extra possibilities for the composer and the conductor to compose and control the balance and timbre between the acoustic instrumental sounds and the electronic sound (live processed sound of the instruments). This lends the performance a dynamic flexibility and expressivity, allowing it to flow in time and space.

In the attempt to realize the artistic needs of the project i.e. compositional instructions (new graphics) and live conducting control of both instrumental and electronic sounds, experimental pieces or studies were written, each focusing on specific factor of fundamental control. The first composition for percussion and conductor focuses on volume control and synchronization, raising the question as to how it feels to "grab" the electronic percussion sound, control its volume, from beginning and end. How can the conductor make sound appear from silence and disappear (crescendo-diminuendo?) How does it sound, feel, what does it artistically or aesthetically for the compositional need of the composer? Does it fulfill the composer's artistic needs?
To find an answer, a computerized imitation was made of a real performance allowing a conductor to read and play a written score and practice the interactive conducting. This part of the study is still ongoing.

Conclusion and Future work

Despite the early stage of the study, the first experiments in realizing the potential of the ConDiS system have shown, that it is possible to achieve the desired results. Sound can be successfully and expressively dynamically altered, and can be moved convincingly. But there are limitations related to the human brain and its capacity for processing multiple sources of information in parallel Where are the boundaries? was the volume control turned on or not, or was it effect control or... Perhaps with more practice these limitations will be reduced. Perhaps, rather than simply functioning as a tool to reflect existing compositional and conducting skills, ConDis needs to be allowed to become a driver for a new way of composing. New compositions might take into account the limitations of the extended role of the conductor. Confusion and clarity are fundamental issues, less is perhaps after all more.

Future work will focus on artistic needs and goals. Short and simple compositions for one or two instruments (next one for flute and conductor) will be written focusing on selected controlling functions.
Further conducting practice is needed to establish the extended conducting technique - in other words, to discover whether it can become "natural" or put into memory (established as a natural routine, like other motor routines, controlled from the cerebellum - ?????)the brain). Work has been scheduled with professional conductors to practice and obtain feedback in relation to various musical and controlling gestures. Some technological adjustments and upgrades will be needed, such as testing out new software/hardware like the NI Mate software recently released version 2.13 which supports the Kinect 2.0 for MacOS. Plans are being made to test this in future versions of ConDiS.

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