Gest-O: Performer gestures used to expand the sounds of the saxophone

John Melo
Universidad Icesi
Cali, Colombia
john.melo@correo.icesi.edu.co

Daniel Gómez
Universidad ICESI
Cali, Colombia
dgomez@icesi.edu.co

Miguel Vargas
Instituto tecnológico Metropolitano
Medellín, Colombia
miguelvargas@itm.edu.co

ABSTRACT

This paper describes the conceptualization and development of an open source tool for controlling the sound of a saxophone via the gestures of its performer. The motivation behind this work is the need for easy access tools to explore, compose and perform electroacoustic music in Colombian music schools and conservatories. This work led to the adaptation of common hardware to be used as a sensor attached to an acoustic instrument and the development of software applications to record, visualize and map performers gesture data into signal processing parameters. The scope of this work suggested that focus was to be made on a specific instrument so the saxophone was chosen. Gestures were selected in an iterative process with the performer, although a more ambitious strategy to figure out main gestures of an instruments performance was first defined. Detailed gesture-to-sound processing mappings are exposed in the text. An electroacoustic musical piece was successfully rehearsed and recorded using the Gest-O system.

Keywords

Electroacoustic music, saxophone, expanded instrument, gesture.

1. INTRODUCTION

In Colombian context, there is an evident gap between the musical community and the techniques related to electroacoustic music. On one hand, because the curriculum in the majority of music schools, from junior to senior level, doesn't encourage the use of technology; on the other hand, because the instrumental groups remain mostly traditional. Thus, the daily life in music schools is not too close to the use of technological devices in the process of assembly, performance or production of electroacoustic works.

This project aims to create useful open source tools to be shared with the musical community, particularly through the expansion of acoustical musical instruments. It is expected in the mid-term that new composers and musicians will be able to familiarize with pieces and electroacoustic composition through performance and experimentation.

The first stage of the project has been focused on the expansion of wind instruments, knowing that most of the performers have had little contact with the processing of sound and neither with synthesizers. After testing with saxophone players and trumpet players, this investigation focuses on the saxophone.

This article describes the development of a hardware system incorporated to the saxophone connected via blue tooth to a DSP system developed in Pure Data [1]. Various user tests were carried on with professional saxophone players using diverse approaches to find the right gestures. This first stage of the process ends up with the composition, montage, performance and recording of a piece for solo sax and electronics.

The project was aimed at finding gestures that could be used to control a real time sound processing system. Diverse strategies were used to define the right set of gestures. The final used strategy consisted in making agreements between the performer and the designers using an electroacoustic piece as a framework. Mappings between gestures and different processing algorithms were derived from those agreements. Although the strategy proves successful and the piece is rehearsed and recorded, a partial conclusion is that such a system in the future should allow the musician the selection of his/her gestures and let the system adapt to them in automatic fashion.

2. RELATED WORK

Several works have been made with the intention of expanding/augmenting instruments by means of a technological way. Such tools augment the interpretation and compositing possibilities, either way by expanding the techniques to approach the instrument, or by changes in the instrument's sound using real time processing.

Using sensors that translate actions from the interpreter in an analog way, we find Tod Machover and Joe Chung's work with the *Hyperinstruments* project [2]. Hyperinstruments builds a solid ground in instrument expansion and in the approach of the musical community towards electroacoustic music. The term Hyperinstrument becomes one of the ways we can name an expanded instrument; we find in Hyper-bow [3] and Hyper-flute[4], interesting advances in the refinement of the way we capture gestures and in the use of musical gestures to carry out sound expansion, taking into account the physical capabilities of the interpreter.

Along in the same line as the Hyper-Bow we find K-Bow. It's an instrument developed by KMI (Keith Macmillan Instruments) which successfully brings the interpreter and the compositor closer to electronically expanded techniques. Very similar to Hyper-bow, K-bow uses pressure sensors and accelerometers to complete a wireless device that communicates the interpreter's gestures to the computer. Today, a quartet K-Bow piece exists, composed by Douglas

NIME'12, May 21-23, 2012, University of Michigan, Ann Arbor.

Quin and interpreted for the first time by the Kronos quartet in November 2011[5].

The Bass Sleve is yet another project that uses a great variety of sensors in the creation of a real time augmented bass multimedia controller [6]. It has controllers located on the knee, foot and on the instrument, and it has Computer vision image analysis; the global device uses auxiliary movements, different from the traditional movements made by a bass player; these movements can result to be invasive for the interpreter, from which the direct work with interpreters is fundamental.

In the field of the brass instrument family we find in [17], the starting point of expanding brass instruments that take into account performers *traditional* interpretation; several augmented brass instruments have been designed and implemented in the past years, instruments may be more or less invasive depending on the control device used for sound processing, pressure and position sensors, plus in some cases push buttons, seem to be a general choice [16][18] to mention two; augmenting brass instruments have come to the point of developing a whole new interface in which the primary concept of the instrument may become blurry due to its changes, not only physical but in the way instrument is played [19], although we don't have nothing against this approach, our own research showed that traditional music performers, which are our main interest, really don't feel comfortable with *new* controls built in their instruments.

3. GEST-O

3.1 About musical gesture

Musical experience, to denote the moment in which we listen to music, whether it is in a concert, the radio, or an mp3 player, finds itself deeply related to corporal movement [8]. It becomes evident since the origins of music that it is closely related to dance. Moreover, musical terminology uses metaphoric ideas such as allegro, dolce, vivace to guarantee that expressiveness from the performer has the desired intention that the composer conceived [9]. It is clear that human beings are in full capacity to acknowledge gestures and movements that could be violent, joyful, loving [9], and that we can understand between mechanical movement and the reasons behind it [10].

A gesture could be considered in communication, control and metaphor perspectives [8]. When we use gestures to communicate, they serve as means to our intentions, for instance when we interact socially. When we use them under the control point of view, they become elements to manipulate some parameter. Metaphoric gesture is that whose movement is led by a concept. This project is focused in the analysis of gesture as a mechanism of control to communicate concepts conceived by the composer.

A wind instrument performer usually focus his attention in the control of his fingers and the blowing of his instrument, leaving as the only way to interact with hardware, the use of pedals limited at one control at a time. However there is a great amount of body gestures additional to those needed for the interpretation that can be measured through digital systems to be used in real time sound control.

3.2 The sensor

With the goal of capturing performers gestures, the electronic plaque of a Wiimote control was used. Considering that only movement data from the accelerometer and gyroscope is needed, there was no need to use any of the buttons. Also a cable was soldered to the current input to avoid battery weigh from affecting performers interpretation (see image 1).

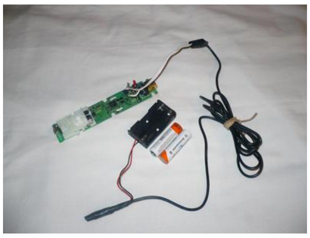


Image 1: sensor

Batteries were fitted onto the performers belt with a two meter long cable and a case was designed so the sensor could be set onto the saxophone in the less invasive way possible. **A** Bluetooth connection with the computer is made via OSCulator software, which, passes data to PureData through OSC[11].

3.3 Tests with different instruments

Initial tests consisted in measuring musical interpretations to measure fluctuations and possible patterns in the performers movements that could be present in different kinds of musical moods.

In case that some pattern in movements could be found, they could be used as gestures to control an instrument processing system in real time. The idea was that, if such natural gestures existed, they would be candidates to be used as control input for an audio processing system. This assumption was made due to the fact that if those gestures exist in any kind of expressive mood and that they were common to all musicians, they would not imply new learning.

In order to get data from the sensor in early tests, a PureData patch was developed to store audio and sensor data from the performances. Recorded sensor variables are shown in Table 1.

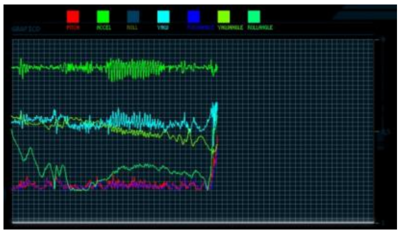
Table 1. Variables the sensor sends while fixed onto the instrument

Variable	Meaning
Acceleration	acceleration
pitch	Y rotation
yaw	Z rotation
roll	X rotation
pitchAngle	Y tilt
rollAngle	Z tilt
yawAngle	X tilt
Audio	Audio

Initial tests were carried out with two professional music performers: a saxophonist and a trumpet player (see images 2.a and 2.b).

a. Test with saxophone

b. Test with trumpet



c. Data in the system

Image 2. User Tests' record

3.5 An approach to gesture analysis

The data gathered from the tests was loaded in a custom application (see image 2.c) for its analysis. Striving to look for patterns between audio and gesture data, work took another road and it was decided to concentrate merely on the saxophone, so the objectives of the project could be achieved in the allotted time. The project leaned toward the reduction of the breach between the interpreter and a specific musical piece. Tests on this second stage were done with a sax student. The attention focused on the search for gestures that were independent from the main performance gestures, such as blowing and fingering. After making several explorative sessions with the performer, a group of independent gestures that the interpreter felt comfortable with were defined. (See left column of Table 2)

As to the musical piece, "Perla" from Colombian composer Jose Gallardo was selected. This is a piece for solo sax and real time electronics. In this piece 6 different sound effects are used which are: grane sampling, ring modulation, reverberation, delay, and multiphonics.

3.6 Rehearsal and recording of the piece

Once the gestures and the control requirements were defined, and the piece was chosen, the development of a PureData application to use on the prototypes final test was started. The application inputs are real time sensor data, and the instruments sound. The output is the transformed sound. The critical part of the development lies in mapping the best possible way the movements, gestures, and actions of the user/interpreter with the processing systems parameters. Depending on the style and the way we approach the gesture mapping, it can considerably alter the way the instrument behaves [12]. In this ongoing investigation all the technical factors of the traditional instruments are considered, in order to achieve accurate and fluent control from the performer.

Table 2. Gestures and their corresponding effects

Effect	Gesture
Grane Sampling On/Off	Jump
\ Grane Amplitude	Upwards Leaning
\ Grane Size	Sideways Leaning (right)
Ring Modulation On/Off	Shaking the instrument sideways
\ Modulation Index	Average between upwards and sideways (right) tilt
Reverb Mix	Downwards leaning
Multiphonics On/Off	Shaking the instrument forward
Delay Mix	Upwards Leaning

In the left column of Table 2 there is a list of processes and the different variables involved in their control. The difference between discrete binary variables and continuous variables was key to the development of the application, as each one of them requires a different type of gesture: a continuous variable requires of a gesture that is equally continuous so the interpreter can control it with certain amount of precision having in mind a range of movement that defines a maximum and a minimum point. A discrete binary variable (i.e. on/off) requires other type of gesture, a gesture that points or indicates but with no defined dimension.

Mapping was made by agreements between the design team and the performer and consisted firstly in defining the possible relations between the type of variables and gestures, secondly on programming algorithms that identify each one of the gestures and, finally, on testing that mapping. This process repeats itself a good amount of times while playing the piece so the gesture, its relation with the instruments interpretation and above all the calibration of the range of movement can be optimized. As an additional constraint to the mapping, the score suggested that at some points various effects should be available for the performer at the same time. In the right column of Table 2 are the gestures that were finally defined with the interpreter that correspond to the necessary variables for sound processing in the left column.

The variables Grane Amplitude, Grane size, Modulation Index, Reverb mix, and Delay mix are all continuous variables controlled with continuous gestures. Grane sampling on/off, Ring Modulation on/off and Multiphonics on/off were of the discrete kind and controlled with discrete gestures.

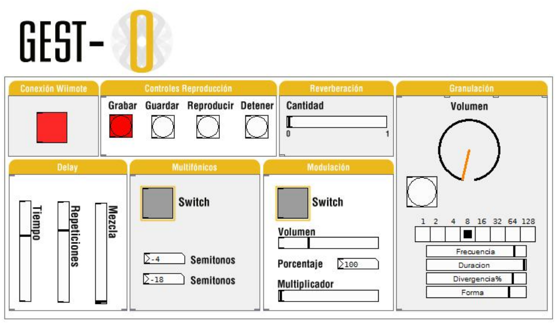


Image 3. PureData application

The Pure Data application was finished with a GUI specifically designed to monitor the processing values in real time, and the changes produced by performers movements (see Image 3). This GUI has all the information of the system status at the moment of the performance, so it is intended to be used as a real time guide. A video of the system running in a performance of the musical piece can be found online [15].

4. CONCLUSSIONS AND FUTURE WORK

Finding gestural patterns in different performers of the same instrument is a complex task even when there are a small number of performers. Instrument players have each different backgrounds, tastes, and ways that lead to different gestures during performance. Although this was Gest-O main objective, due to limitations of time and scope this objective was adjusted to the interpretation of gestures from a specific performer to meet the needs of a specific piece.

Despite taking a different path, it is probable that the search for common gestures might not be the right choice in projects of this type. Another choice could be a system that allows a user to choose his/her own gesture and to choose where it is going to be mapped to. The development of such adaptive systems is a direction in which this project might evolve.

A first goal of creating a system useful for the transformation of saxophones sound using performer gestures was completed. The rehearsal and recording of the piece was done correctly and the results are musically satisfactory. The performer, although it was his first work with electroacoustic music, was very pleased to find out that such alterations of saxophones sound could be achieved.

Universal gestures (greetings, surprise, anger), change between societies depending on existing cultural codes. Although there are advanced studies about gesture and speech [13], gesture and music [14], it is known that hand movements and facial expressions that go with speech are an inextricable aspect of communication [8]. Music, to be communicated to a listener, has to go through at least two important steps: a composer writes in the language of sound, so a performer can communicate the listener the work conceived by the composer. All this social, cultural and personal factors additional to the complex musical abstractions make the big idea of a series of standardized gestures almost out of reach. If technical factors of each instruments performance are added, possibilities of generalization are reduced even more.

4. ACKNOWLEDGEMENTS

To the ACORDE research group research group in the ITM Medellin for their preliminary discussions. To Jose Gallardo for composing “Perla”. To the performers Paulo Sanchez, Diego Murillo and Oscar Plaza for their collaboration in the tests. To Juan Carlos Perez for the documentation. Finally to the Leonardo research group in ICESI University for facilitating the space and resources to develop the project.

5. REFERENCES

[1] Puckette, M. (1997, Mayo 7). Pure Data: Another integrated computer music environment. Second Intercollege Computer Music Concerts. Tachikawa.

[2] Machover, T. & Chung J. Hyperinstruments: Musically Intelligent and Interactive Performance and Creativity Systems. In Proc. Intl. Computer Music Conference (1989)

[3] Young, D. The Hyper-Bow Controller: Real-Time Dynamics Measurement of Violin Performance. In Proceedings Conference on New Instruments for Musical Expression (NIME-02), Dublin, 2002

[4] Palacio-Quintin C. The Hyper-Flute. In Proceedings Conference on New Instruments for Musical Expression (NIME-03), Montreal, 2003.

[5] http://www.keithmcmillen.com/k-bow/overview

[6] Ramkissoon, I. (2011). The Bass Sleeve: A Real-time Multimedia Gestural Controller for Augmented Electric Bass Performance. NIME'11. Oslo, Norway.

[7] Godøy, I.R & Leman, M. Musical Gestures. Sound, Movement, and Meaning. Routledge, 2010

[8] Cienki, A & Müller C. Metaphor and Gesture. John Benjamins B.V., 2008

[9] Camurri, A., & Moeslund, T.B. Visual Gesture Recognition, From Motion Tracking to Expressive Gesture, in Musical Gestures, Sound Movement, and Meaning. Routledge, 2010, 238-263.

[10] Schneider, A. In Music and Gestures: A Historical Introduction and Survey of Earlier Research, in Musical Gestures, Sound, Movement, and Meaning. Routledge, 2010, 69-100.

[11] Wright, M., & Freed, A. (1997). Open Sound Control: A New Protocol for Communicating with Sound Synthesizers. Proceedings of the international Computer Music Conference. International Computer Music Association

[12] Hunt, A., Wanderley, M. M., & Paradis, M. (2002). The importance of parameter mapping in electronic instrument design. NIME'02. Dublin.

[13] Mcneill, D. Language and Gesture. Cambridge University Press. 2000

[14] Dahl, S., & Friberg, A. Visual Perception of Expressivenes in Musicians’ Body Movements. Music Perception vol. 24 (5). University of California Press. 2007

[15] Video of the performance: http://youtu.be/8xQ6nmxMNqs

[16] Burtner, M. The Metasaxophone: concept, implementation, and mapping strategies for a new computer music instrument. Articulo: Organised Sound, Volume 7 Issue 2. pag 201-213. Cambridge University Press. 2002

[17] Cook, P & Morrill D. Hardware, software, and compositional tools for a real-time improvised solo trumpet work. presented at the Int. Computer Music Conf. (ICMC), Columbus, OH 1989.

[18] Schiesser, S & Traube C. In Proceedings Conference on New Instruments for Musical Expression (NIME-06), Paris, 2006.

[19] Favilla,S. Cannon, J, Hicks T. Chant, D & Favilla P. Guilsax: Bent Leather Band´s Augmented Saxophone Project. In Proceedings Conference on New Instruments for Musical Expression (NIME-08), Italy, 2008.