On The Cohesion of an Electronic Device Ensemble

Miguel Vargas, Andrés Saldarriaga, Fredy Alzate

Instituto Tecnológico Metropolitano -ITM-
Medellín Colombia
miguelito.vargasf@gmail.com, jandreus87@gmail.com, fredyalzate@itm.edu.co

Abstract

The use of DIY methods in the guidance of students in their own computer music formation processes are just as important as any of those focused on studying an academic text; the access to open information and technology are growing at a fast rate and with a bit of a tinkering mind, the periods of time it may take to build your own embedded acoustic instruments (Berdahl, 2014) comes more at hand with the resources you may find on communities like **instructables** or **thingverse**. Contemporary practices like net-work music become also more accessible thanks to the advance of the possible communication protocols and device robustness; in less than 40 years if we count up from those experiments with low level assembler for hacking a chip and serial protocol for its communication with others (Gresham-Lancaster, 1998) to interfacing a couple of raspberry pi's throughout OSC protocol; the proliferation of technology also comes with some problems like the losing of an intimate relationship between interpreter and instrument or the unknown that can be the manipulation of timbre by audio processing techniques or interpretation instrument possibilities to a composer.

This paper summarizes the process of cohesion of an electronic device ensemble where students and researchers live new expression practices throughout the use and misuse of technology, such practices have brought up questions and possible ways to enrich the study of electronic music, as well as music language itself.

Keywords

Ensemble, Electronic Instrument, Network Music

Introduction

We're living exciting times, as exciting as the times lived when big changes in the conception of music took place i.e. pass from counterpoint techniques to rigorous classical structures or the technical expanse it brought the arrival of new timbre and instruments such as the **intonarumori,** these big changes also denote a change in the periods of time: Baroque, Classicism, Futurism.

Technological advance has made possible from hobbyists to academics a more friendly relationship with the implementation of technology, all thanks to open communities such as **Arduino**, **Raspberry Pi**, among many others; to *build your own alien instrument* (Ghazala, 2005) is a common practice in an ensemble and the complexity of possible ways of interaction with your instrument can be over-whelming (Miranda & Wanderley, 2006), the fast growing rate of technology can put a large distance between interpreter and instrument, a lot of the electronic interpreters now days lack the relationship a violinist has with his instrument; you can find a performer tinkering and tweaking his instrument 10 minutes before a concert, "...Constant technical improvement means eternal unfamiliarity with the instrument"(Perkis, 2011), and the more complex the more possibilities the instrument may have either to generate and organize timbre or to interface with it throughout diverse controllers; the amount of practice time an interpreter should have with its instrument in order to be able to express him or herself is no small matter, taking Tim Perkis's experience performing network and electronic music is a perfect example of how the practice with your electronic instrument should be, he has not made changes to his instrument for several years (Perkis, 2011); his relationship with his instrument is for sure that of the violinist, so the music he expresses through it can communicate with the rest of the ensemble a lot better with musical language.

We see electronic devices as someone may see a violin or a bassoon, as instruments for artistic expression, and like with any other instrument electronic instruments have had an evolving process in its luthier activities (Jordà, 2005) as in the orchestration, composition and interpretation techniques used in the performance with new interfaces for expression; but as the proliferation of technology grows also grows the need for documenting it's uses and generating tools that ease the dirty work for composers and music interpreters, so that they can build up a more intimate relationship with electronic devices and their characteristics as instruments for musical expression.

We are indeed living exciting times; lately many of the founding fathers of computer music have been passing away, not many years ago Max Mathews left us with the gift of unit generators, Jean Claude Risset passed recently, leaving us a lot of the techniques used for sound synthesis, how exciting is a period of time where its biggest exponents are either alive, or have died when you are alive?, what must have been the feeling a composer had living in 1730 while Bach was alive, and music was living a huge evolution with the counterpoint?.

In order to shorten the gap technology may bring into the performers and composers and work around the idea of a collaborative group that can document and develop tools to pass the know hows to newcomers and that "technical background" (Ogborn, 2012) may be lessened, we've defined some aspects of methodology that can be useful, and have started to develop the resource documentation so participants may use or take it further in their computer music practice.

Some approaches were made before choosing a path that could achieve what we were looking for. Students come to the ensemble with little or no knowledge at all of what they can use or how they can use it in order to express themselves, their passing through the ensemble are long hours in front of a computer learning **pure data**, **chuck** or **super-collider**, or building prototype circuits on protoboards so they have less time for their musical interactions with the rest of the group; we started to need a set of tools, ready-made and out of the box, so students could learn as they interact musically with each other as well as starting to build their own instruments, and for the ensemble to start implementing a way for documenting developments that could be used or improved later by anyone to either perform with an instrument or compose for it; let's say we have a group of light control interface modules, We can catalogue the light control interface, from its building to its calibration and mapping algorithms so they can be uploaded to an arduino board and plugged to a laptop out of the box, to its technical control capabilities, let's say the module can only manage long time envelopes -this for composing purposes-, as the catalogue grows bigger with resources for newcomers and subjects to study deeper for old members, you can enhance the practice flow with technical studies and ensemble musical practice; the inter connectable module idea may be similar as the ones lived in some laptop ensembles like PLOrk (Smallwood et al, 2008).

We took a gigantic step and started to develop stomp-boxes using the **beagle bone black**, and open CAD software for both the casing and circuitry design.

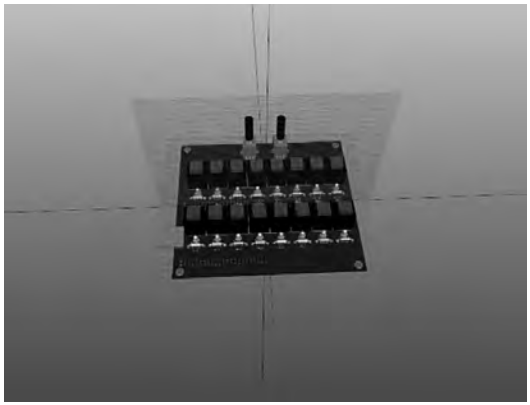

Figure1. Final model of a sequencer control interface using the software KiCad and FreeCad

This approach of course excluded newcomers and developing time left very little for musical practice, although we wanted the idea of having homogeneous sets of instruments that could be added and sorted as classified families of electronic instruments, depending on their type, of controllers, generators, software, hardware, etc.

We decided then to look elsewhere for an electronic device everyone in the ensemble had or could have access to in an easy way, and start from there; smartphones were those devices: electronic devices that fit in your pocket, that already can connect themselves to a network, that already have plenty peripherals like accelerometer, tilt sensors, proximity sensors, among others, and saw it as a nice way to introduce newcomers to computer music.

At the same time the search for a solution of the sound system characteristics was done keeping in mind, that we wanted to be as free from complex technical raiders as possible while maintaining sound quality and to get as much mobility as possible for the ensemble. The International Association of Laptop Orchestras (ialo, n.d.), is a wonderful wiki that hyperlinks some of the most important ensembles around the globe, PLOrk is one of them; seeing their implementation of a half dodecahedron speaker gave us our own approach. A

dodecahedron style speaker takes the form of the regular twelve face polyhedron, each face has a speaker (half dodecahedron speaker has six faces); this brings the sound of an electronic device closer to how sound is propagated by an acoustical instrument, enhancing the way an electronic device may sound and bringing us closer to a fully mobile ensemble; working in collaboration with the acoustics research group, comprised also of teachers and students a dodecahedron speaker model was implemented to finally bring cohesion to our idea of an electronic ensemble.

Figure 2. Final prototype of the dodecahedron speaker

Smartphones sending OSC data to an audio server whose output goes to a dodecahedron speaker is our first possible orchestration as we want it's characteristics to be; mobile like an acoustic ensemble, with the capabilities of connecting to a network and with the use of electronic devices for musical expression. Cellphones became the first family of electronic instruments to start theorizing with; this will be widened further in the paper.

About the First Family of Instruments

Smartphones are a very powerful mobile technology that is already at hand, and it may be easy to overlook this due to their daily use, but these devices, depending on their hardware characteristics already integrate gps, sensors like accelerometer, gyroscope, magnetometer, proximity, and the list goes on, although it would possibly take some tweaking to access them all; and let's not forget their networking, Bluethooth and microphone. Since the idea was to live processes of the sort exposed earlier, we began with how to integrate OSC protocol to the ensemble, in this activity some of the students started their OSC and networking studies while others went further as we defined a standard osc addressing style guide for the messages each could send to communicate with a member of the ensemble or with another performer from another ensemble when it happens. So it would not get to fuzzy for newcomers we defined a simple address structure that could later become more robust, id's where defined for each performer and messages should start by the /id address followed by the type of instrument and its value so a possible osc address would be **/id/marimba/i.** Being the id usually the name of the performer, marimba a percussive instrument and one integer to define the note, if the instrument is sending more than one parameter then new addresses are added like so **/id/synth/env/i i i i,** for a synthesizer that's sending frequency and ADSR information; defining the style guide on that very important protocol for the ensemble, allowed newcomers to start learning about addressing through a network and the ones that already knew how, simply could take it a little further by packing their addresses in a bundle for instance. Finally a simple application gui was developed using **Processing** and was installed on each smartphone before finally moving on in to a ready-made tool developed by Iglesia Intermedia, **MobMuPlat** (Iglesia Intermedia n.d.); is an app that can be easily found in the app store or play store and with it you can create controls for whatever pure data patch you have on your computer, or uploaded on your phone if you wanna use your phone as the instrument itself, it also deals with a big load of the connection and package loss issues that comes with handling osc data (Ogborn, 2012) implementing some features of its own to handle osc protocol; finally a pure data patch was developed to receive the messages and send them to each member's subpatch, now we could start practicing some music with networked smartphones; over the practice each could tune up how they sound or how they used their controllers (percussions, envelopes, delay times).

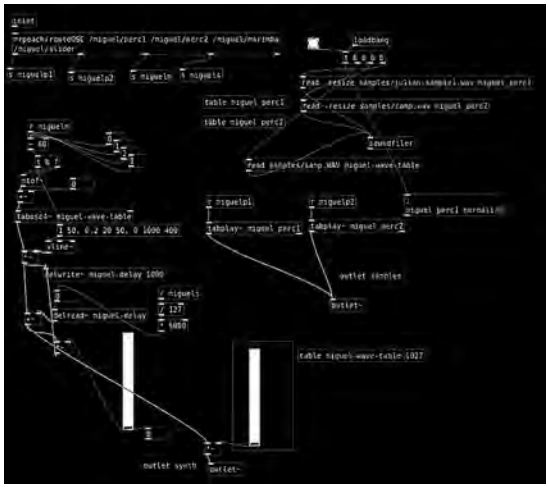

Fig 3. Pure Data subpatch from one performer

As we experimented with the smartphones, felt the differences between each devices hardware through the latency they presented, some may be a little "jazzy" or even hard to ensemble due to the long latency times, of course latest technology usually doesn't present too much of a problem in this matter with the proper bandwidth. Latency time is one of the issues network music gets involved in its performance, so a need for cataloging smartphones and latency times is needed for its orchestration theory as a family of instruments in an electronic ensemble.

About the Sound System

Omnidirectional sound sources or dodecahedron type sound sources due to their geometric form, are those acoustic sources capable of irradiate sound in every direction, they are widely used in the field of acoustics to make sound measurements. An OSS has a factor of directiveness equal to 1 (Q=1); this fact means that the sound source can generate the same sound pressure at a given distance no matter the propagation direction of the sound. To achieve this, it is necessary to consider the dimensions of the dodecahedron speaker compared to the wavelength and that measurements are done at a given distance; in practice an OSS needs to fulfill omnidirectional propagation for a range of frequencies from 100 to 5000Hz.

With this information in mind, the development of the speaker was done by measuring and analyzing sound propagation with different kinds of speakers, the chosen one was the one that had the best quality/price characteristics.

Currently different sorts of amplifiers are being tested to leave the speakers active, this will make them heavier but free from pre-amplifiers, and to find the one that best accommodates to the speaker characteristics because this will influence in the speakers' frequency response as in its acoustic potency.

Why Network Music

Computer ensembles go way back, in the late 70's in the San Francisco bay area an open group of musicians was formed and started experimenting with microcomputers like the MOS KIM-1, interconnecting them with a very low level connection. The League of Automatic Music Composers (LAMC), was perhaps the first collective to officially use the term "network computer music" in their performances (Gabrielli & Squartini, 2016). Now days the practice of network music is gaining strength and becoming more popular around the globe, courses on the subject have been imparted in platforms like **Kadenze**, but if you think of it, if a couple of performers send data to each other through a network, it could be considered network music and network music is more popular than you may think, like the use of a conductive pulse used by PLOrk (Smallwood et al, 2008); network music can have various types that vary across local and remote connections as well as synchronous and asynchronous communication protocols (Barbosa, 2003).

One of the ways network music can be practiced (We find this way to be one of the most gratifying), is not so much to send data through OSC protocol for instance, but to send audio streams from a remote node to another, for this to be achieved with no latency issues and minimizing the loss of data packets a high speed dedicated internet connection is needed, 50Mbps for uploading and downloading data at least -We learned this in one of our past performances-; this makes it a bit harder for performers that have no access to this type of connection, and at least on our local context basically only institutions may have this sort of connection throughout RENATA -National Academic Net-work of Advance Technology for its English translation-.

We have been part of some network music concerts of this type, always with institutional support, and in this type of performance we found the main reason to make network music a big part of the ensemble: multiplicity of spaces.

The change in music paradigms throughout the last 100 years has been very exciting also, like defining any timbre (synthesized or not) as being interesting material for expression is one, this brought a ships horn and all those "noises" to be taken into account in the musical practice; the idea that music is an art of time and space is another, now we see the space where the musical phenomenon is occurring to be an important part of music, i.e. sound sculptures, the plastics of sound; these are some of the concepts and forms derived from this notion. Cage's ideas on the activity of sound happening in a temporal space can give you a view of the importance and on the contribution the concept of time-space brings to music -we now have the way to experiment with time-spaces-.

Using high speed interconnections to send the sound generated by a violin in a concert hall will also have in its stream the characteristics of the hall itself; the importance of the resonant room, or better, the resonant object, was demonstrated widely by Alvin Lucier in his work "I'm Sitting in a Room". The idea of being able to experiment with a big time-space comprised of different spaces is what makes network music a must do practice in our ensemble.

Although this type of concert is not even a monthly activity, due to the long periods of time it may take to produce one presentation: preparations, musicians, institutional bureaucracy, rehearsals, networking configurations required, can be some of the issues one may encounter difficult in order to prepare this type of concert, at least in our local context; not everyone can afford a connection that handles those high speeds, it cost a lot to stream audio from one place to another not only monetarily speaking, but computationally. J**ack** is the most robust tool to achieve this at the moment, and its best implementation would be on a Linux based distribution, configuration problems may arise in Windows or OSX; but even with the problems that may arise in the practice of this type of network music, we see it as one of the most exciting fields in the current contemporary music practice.

With a growing popularity you can find peers which whom you can practice it in several countries, in Latin America, our geographic location you can find network music practice in countries like Brazil, Colombia, Peru or Chile; the tool commonly used for it is **jacktrip**, a tool that handles audio streams between nodes through JACK; currently a live usb with a Linux distro is being cooked to offer those who would like to test an out of the box system configuration in order to practice network music, the live usb is based on the Ubuntu based flavor distribution maintained by **KXStudio** ("KXStudio", n.d.), this was done to bring musicians closer to network music practice and are not well familiarized with the required tools and configurations, also is one of those ready-made tools We were discussing earlier.

Conclusions

The amount of technology at hand now days is overwhelming, and the need for those out of the box tools comes even stronger, take jacktrip for instance; jack's best implementation is on a Linux based operating system some problems may be encountered on Windows or OSX, this makes it harder for people that wants to practice network music and does not work on Linux, a live Linux based usb with all the configurations ready can bring closer musicians of any sort to the practice of network music.

The types of electronic devices that can be used for musical expression being sound generators or control devices is quite overwhelming as well, by the development of shields, stompboxes, etc., that a computer music student or an electronic music hobbyists, may use for their electronic music practice and experimenting can be of great aid for bringing closer the relationship between instrument and performer so the person can also concentrate on the artistic part.

Finally, the need for starting to design orchestration information for electronic devices takes more importance with each new device that appears on the market, it's very exciting to see a pouring sea of information and technology that you can find by a click; a way for the ensemble to become more consistent would be to construct a method for composition and interpretation purposes, a possible structure for this method is, and for each type of object:

- Type of object: whether it is a control object, generator object, software, or hardware
- Object capabilities: ranges, interpretation possibilities -trigger controller, envelope generator, etc-, timbrical or controlling examples
- How-to: either how to build it, or how to use the existing object in the ensemble's instrument warehouse
- Repertoire examples

Let's say we want to implement a 555 timer chip touch

sensor we read about in Forrest Mims's electronics notebooks, its integration in the ensemble's method could be:

- Type: controller, analog, hardware
- Object capabilities: Trigger, piano style keyboard. Examples: piano and sampler software being controlled by the touch sensors
- How-to: printed PCB circuit to make a printed board using one of the existing diy techniques to do it, how to plug the developed module to an arduino and upload the software algorithm and connect it to a laptop.
- Repertoire examples: examples of existing works, or works composed members of the ensemble

Like this the ensemble may build a method that grows in time with collaborations made from members through computer music practice in the ensemble, bringing it closer as a standard musical method can be, and stimulating a more fluent relationship between musicians and technology

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Authors Biographies

Miguel Vargas is a musician and digital artist, researcher and teacher in the arts faculty of the ITM

Andres Saldarriaga is a music technology grad student who is making his thesis on network music

Fredy Alzate is an Electrical Engineer specialized in acoustics and is a researcher and teacher in the arts faculty of the ITM