Ghost Music: Experiments in Invisible Musical Interfaces

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ABSTRACT
The *Ghost Music* project is comprised of a series of wearable instruments that allow the wearer to create real music simply by pantomiming playing an instrument.

Keywords
MIDI Interface, Wearable Computer, Fashionable Technology, Digital Music, Invisible Instruments

INTRODUCTION
Ghost Music is part of a larger body of work by designer Scott Peterman that uses emerging technologies to liberate the creative process from the studio, theater, and concert hall and to encourage spontaneous performance throughout daily life.

Under the tutelage of Fashionable Technology pioneer Dr. Sabine Seymour, Scott has partnered with musicians from the New School's world-renowned Mannes School of Music and School for Jazz and Contemporary Music to craft fully functioning prototypes for Ghost Trumpet, Ghost Trombone, and Ghost Tuba MIDI controllers. He is currently exploring gyroscopic control for a pair of drum gloves and is working with an on-body sensor to model a virtual piano.

INSPIRATION
The twentieth century saw frequent bursts of innovation in the manufacture and design of musical instruments. From early novelties by Russolo and Theramin to instrument modification by John Cage and Ivor Darreg; from Laurie Anderson's tape-bow violin abd Michel Waisvisz' electric Kraakdoos, to the hyper-speed advances of the 1980s in MIDI controller design (see Bill Aitken's SythAxe and Starr Labs' Ztar) and functional deconstruction, (Robert Grawi's Gravikord and Alan Gittler's guitars); and finally, to turn-of-the-century labors of love, such as Yuichi Onoue's Kaisatsuko or the bizarre Moodswinger Yuri Landman built for the band *Liars* in 2006 - advances in music composition and mainstream music technology have been accompanied by flurries of invention at the technical fringes of the art.

But almost none of these instruments have brought the Dionysian joy of actually creating music to a wider audience, or the act of performance out into the "real" world; if anything, inventions appeal initially and often exclusively to the most experimental of musical spaces. Recently, mainstream technologies, in particular gaming systems such as Harmonix Rockband and the Nintendo Wii, have begun to re-envision how music is created and enjoyed, but such systems still generally restrict the player to performing in front of a TV or computer screen.

And regardless of their penetration into popular culture, none of the surveyed instruments or technologies make significant progress in creating controllers (other than those for the keyboard and the drums and a few experiments with the guitar and violin) that function in analogous ways to the instruments they are "controlling." Trumpets, tubas, basses, harps, cellos, violas, flutes, and nearly every other instrument are most often "played" using a keyboard.

EXPERIMENTS
I have already prototyped a number of these Ghost instruments, including the Trumpet, Trombone, and Tuba. I have begun experimenting with Drums and Keyboard, with plans to eventually tackle Guitar, Violin and Upright Bass as well.

All instruments to date have been built using the Arduino platform, with prototyping occurring on a variety of different boards (Duelimanov, Uno, Mini, Seeduino film) and an intended final execution using the LilyPad wearable Arduino controller.

Pressure Sensor (Brass Mouthpieces)
A great deal of experimentation went into determining the correct method for managing the input of a player's breath into the instrument. Initial explorations involved exposed piezo elements and electret microphones, with a brief detour into computer fans. These options proved insufficiently sensitive, and they did not meet with approval from consulted musicians: they were insistent that pitch control was less about the strength of breath and more about the shape of the mouth.

This led to the exploration of pressure sensors, including TDH30 industrial pressure transducers used in weather balloons (consumed too much power and required custom hardware tuning to ramp back from their default 3-10,000 psi) and the DesignFlex PSF102 pressure switch, made for

sip/puff wheelchair devices (incredibly accurate but far too big for a wearable). Freescale Conductors' MPX4115 series provided the best blend of default range (2.2 to 16.7 psi), size (about the diameter of a US quarter) and power consumption (.2-4.8V Output, allowing the device to run off over-the-counter battery enclosures).

The musicians requested adjustments to the exact placement of the sensor but did not seem bothered by blowing directly into their skin. Other users complained that it blocked the face, and that the prototype robbed the experience of the grand gesture that was possible when simply pantomiming. This led to a discussion of additional form factors for the pressure sensor, including one that allows for the attachment of a plastic tube, which could be run up the thumb to a mouthpiece. This will be attempted in the next prototype.

Soft Circuits (Trumpet/Tuba Fingering)

A broad survey was done of available technology in an attempt to best imitate the finger motions used to close a trumpet's valves. Flex sensors proved too unreliable and prone to breakage, and velostat conductive shielding stretched along the finger returned too broad a value.

For the initial working prototype, simple buttons sufficed, though attempts were also made to use the finger to complete a circuit both across a single piece of conductive ribbon and through the finger using the human body as the ground. The ribbons were too noisy, while through the body conduction showed promise.

However, feedback from both trumpeters and the EnsAD team stressed the importance of using the full range of finger motion in order to truly perform – as opposed to pressing any sort of button or piece of fabric in the palm. So a return to a flex based method of sensing is called for.

I have recently been introduced to Matt Johnson and his Bare Conductive non-toxic conductive ink, and he and his team had promising results after painting the ink onto stiff paper and then pressing or bending it to return force and flex data. The possibilities this opens up are truly cutting edge, with the player simply painting the back of their fingers with this inexpensive and non-toxic substance, then attaching leads and actually using the finger itself as the sensor, allowing total mobility and best approaching true invisibility in the instrument.

Ultrasonic Rangefinder (Trombone valve)

I first prototyped the Trombone with the MaxSonar-EZ1 Rangefinder. Data was accurate enough to get the necessary six levels of control needed to produce the trombone's range of notes, though the data was extremely noisy.

In the code base, some work is needed to affectively slide between notes. MIDI sends each note as a discreet ON or OFF signal, and has an entirely separate command for initiating pitch bend, so code will need to be written to calculate the length of a slide and then execute the corresponding amount and duration of pitch bend before turning the final note ON.

To attempt to get less noisy data from the sensor, an IR solution had been planned for the next iteration, but once again Bare Conductive inspired a new direction, as they have already achieved a working proximity sensor with their ink that has returned accurate readings for up to a meter. This will be an area of exploration going forwards.

Ongoing Experiments (6-axis sensors, Kinect)

Drums are at present a challenge of mastering the well-documented process of 6-axis control using a paired accelerometer and a gyroscope. I currently have a functioning drum wand that recognizes a quick stop within in a specific region of space. Code needs to be written to initialize the regions as separate notes and to link hand velocity to note velocity before user testing can begin. It should theoretically be possible to get the drum gloves work with the Rockband software, as I have achieved the reverse and used Rockband drums as a MIDI controller.

Keyboards present a challenge in the degree of mechanical complexity involved, but as the only musical instrument I can remotely play they are a must. Perhaps this moves beyond the current capabilities of pure wearables. I have recently been experimenting with modeling space using an on-body Xbox Kinect, and this could prove a very fruitful way of recognizing the broad number of hand positions and gestures that make up the act of playing the piano.

ITERATION

It is clear that there is much work to be done refining the brass prototypes, but the direction is clear and numerous new technologies have already presented themselves for further iterations and expansion into additional instruments.

With completed prototypes the interesting work begins: collaborating with both professional practitioners and non-musicians alike to refine both the wearable's method of recognizing gestures and that very set of gestures that now constitute "playing."

My hope for this project is that it simultaneously constrain the act of play to a newly formalized practice of formal musicmaking and yet liberate musicmaking from the mechanical constraints of the instrument and allow it to exist whenever and wherever it wants, as a series of wild, perhaps slightly ridiculous performative gestures.

Finally, and more than anything, I simply live for that gasp, at the charged moment of someone waggling their fingers in the air and real, unique, one-of-a-kind music coming out. Technology can be used within and integrated into our lives, our garments and our worlds in a variety of ways, for better or worse. But just because something is ubiquitous does not mean it cannot be magical as well.

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TECHNICAL RESOURCES

Fabrick.it conductive ribbon:
http://fabrick.it/files/datasheets/fabrickit_ribbon_datasheet.pdf

Freescale Conductors MPX4115 pressure sensor:
http://www.freescale.com/files/sensors/doc/data_sheet/MPX4115A.pdf

Transducers Direct TDH30 pressure sensor:
http://www.transducersdirect.com/HeleoCart/Data/SoftGoodPreview/TDH30_(1.11).pdf

Design Flex PSF102 Switch:
http://www.designflexswitches.com/switches/psf102.php

Bare Conductive Ink:
http://www.bareconductive.com/home.html

3M Velostat 1704 Conductive Film:
http://www.all-spec.com/downloads/3m/TM1704-36_060110m.pdf

MaxBotix LV-MaxSonar-EZ1 Ultrasonic Rangefinder:

http://www.maxbotix.com/uploads/LV-MaxSonar-EZ1-Datasheet.pdf

BACKGROUND REFERENCES

Attali, Jacques. Trans. Massumi, B. *Noise: The Political Economy of Music*. University of Minnesota Press, 1985.

Demers, J. *Listening Through the Noise: The Aesthetics of Experimental Electronic Music.* Oxford University press, 2010.

Goldberg, R. *Performance Art: From Futurism to the Present*. Thames & Hudson, 2001.

Hopkin, B. *Gravikords, Whirlies & Polyphones: Experimental Music Instruments.* Elipsis Arts, 1996.

Kahn, D. *Noise, Water, Meat: A History of Sound in the Arts*. MIT Press, 2001.

Holmes, T. *Electronic and Experimental Music: Technology, Music, and Culture*. Routledge, 2008.

Huber, D. *The MIDI Manual, Third Edition: A Practical Guide to MIDI in the Project Studio.* Focal, 2007.

Milner, G. *Perfecting Sound Forever: An Aural History of Recorded Music.* Faber & Faber, 2010.

Nyman, M. *Experimental Music: Cage and Beyond (Music in the Twentieth Century)*. Cambridge University Press, 1999.