Designing Prototype GO for Sound and Light

Eva Sjuve
Institute of Digital Art and Technology
School of Computing, Communications and Electronics
University of Plymouth, UK
eva@moomonkey.com

ABSTRACT
This paper describes the development of a wearable interface for sound and light. Light can be visually expressive and perhaps stimulating if integrated into the design of a musical interface, adding a visual element of light and shadow to the performative space. GO is an experimental controller for live interactive performance of sound and light, a wearable controller with sensors and switches as inputs. The sonic output from the controller is programmed in Pure Data. Visual expression, in the form of light, is added to the sonic and physical expression. The purpose is to develop a flexible controller that can be used for various improvised sound and light performances. Light source as material, and the use of light integrated into the design of a wearable controller in performance is briefly discussed. The compositional rules and structure of the sonic composition is discussed in relation to the visual expression.

Keywords
Interface design report, live electronic music, gesture, sound and light expression using sensor technology, embodied technology, embodied action, wearable computing, improvised musical performance, wearable instrument, phenomenology.

1. INTRODUCTION
Composers of electronic music, such as, as Iannis Xenakis [1] and Ralph Lundsten [2] have incorporated light into their musical expression, in the form of installations and performances. Even if light [3] is used extensively in the performing arts, it is not often incorporated in the design of wearable interfaces for musical expression. An opportunity to conduct research in sound and light, during a two-month Artist in Residency, Nordic Resort [4] at the Norwegian Theatre Academy in Fredrikstad [5] was offered. During the residency, a sound and light controller named GO, for improvised embodied interaction was development and user tested. The controller is based on a PIC microcontroller with various sensors and switches as inputs and light and sound as outputs. Experimentation with various types of lights was part of the research.

2. EMBODIED TECHNOLOGY
The purpose is to develop a variable controller used in sound performance with adding a light component to the expression, to create a visual feedback to the sound. Gesture control of electronic music has been discussed extensively and is not included in this report.

3. PREVIOUS AND RELATED WORK
Artists and technicians have explored the design of musical interfaces for sonic and/or light expression, during the last century. A historic survey of this developement, can be found in *Gestures, Interfaces and Other Secrets of the Stage* [6]. Figure 1 shows one early example of a sound and light performance, *Electrical Bones*.

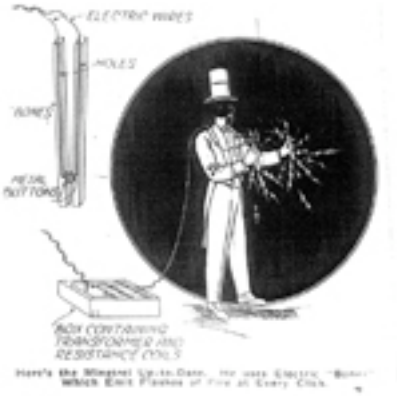

Figure 1. Electrical Bones 1918

Previous related work was the development of *Kinesis, in* 2002-2003. [7] This is a gestural controller, processing audio with max/msp [8]. A portable interface for improvised electronic was developed in 2001, *Fake Radio* [9], where the sound processing was implemented using max/msp.

This paper is not covering the contemporary context of artists/ technologists working with wearable computing, or sound and lights coupled together, but some practitioners should be mentioned briefly, working in the context of sound and/or light, are *Flexgrid* by James Clar [10], *LED* Clothing by Leah Buechley [11], Diane Burgoyne's *Performer and Light Sensors* [12], and Greg Shakar's work combining sound and light [13].

3. DESIGN IDEAS
The idea behind this project was to create a controller to generate both sound and light from physical movements. Experience from previous work with wearable controllers, has

shown that the design had to meet certain criteria, to be implemented in the design,

1. The performer should control all sound and light expression from the wearable interface, and not by a technician from a remote place.
2. Portability issues, the controller's input and output has to be disconnected for transport
3. Exchangeable outputs, the lights
4. Exchangeable inputs, such as switches and sensors

To work with light requires additional design features, such as type of lights, luminosity, color, and correspondence/ or not with sonic gestures, and the physical mounting of light sources.

Figure 2. A First Prototype

3.1 A first prototype

The construction of the GO controller is the following. The central processing unit is a PIC 16F876A. [14] On the controller are two sensors and three switches. One sensor is an accelerometer, ADXL202 [15], measuring gravity and acceleration, the second sensor is a bend sensor used for volume control. There are three switches on one hand, for controlling the lights on/off, one for changing light patterns and parts of the musical structure, and one chaos switch.

The accelerometer used in the GO controller measures change of speed and orientation in relation to the earth's gravity. It is a two-axis accelerometer, which measures acceleration in two directions.

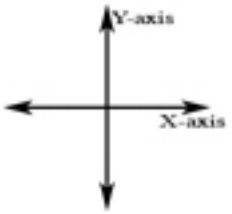

Figure 3. Two-axis orientation of accelerometer

In Joel Chadabe's text *Devices I have known and loved*, on the relation between gesture and musical thought [16] he mentions the most important factor being the relationship between the performers movement and a musical result. The GO controller is developed to enhance the performers gesture with a sonic expression, but also enhance the sonic expression in conjunction with lights. One central idea is to develop a controller for improvisation as a process.

3.2 Notes on performing

Some notes on interactive performance using sound and light. The light material of the performance is used as a suggestive component, to put an emphasis on the mobile space, immediately surrounding the physical space. Why using light in sound performance? The idea is to set up a system to stimulate alternate sorts of experience, and to find a new sonic space to function within as an improviser. Light, as a material belongs to all the performing arts. The use of lights, immediately surrounding the body, creates a new kind of performance spatiality, transforming the human features with light and shadow, with visual emphasis and exclusion. As light and sound are both non-tangible elements, a link between the non-tangible and physical movement is created.

The exploration of improvisation and performance is also a phenomenological one; the immediate response of the wearable technology is in mutual exchange with the performing body. Restrictions created by the technology make a new alphabet of movements, its own language of augmentation, and restrictions. In Merleau-Ponty's work *Phenomenology of Perception* [17], he shows his ideas of the immediate experience of physical movement and perception being in a dynamic relation to perceptions of the world. The body acts here as a transducer, in all perceptions, both in improvisation, but also in relation to culture and technology.

3.3 Sound composition

The physical movement, measured by the accelerometer is controlling both sound synthesis and the structure of the composition. Pure Data [18] is used for the sound composition. The main sensor input, the accelerometer is placed on one arm and the measurements in relation to earth's gravity controls the sound synthesis, on a Y-axis and X-axis.

3.3.1 Compositional rules

Pure Data measures variations on the Y and X-axis, to control, in the current setup, two banks of filters. The largest pert of the sound synthesis is performed in the frequency domain, spectral synthesis. Variations of the filters are based on reoccurring measurements, reaching certain intervals of prime number, (3, 5, 7), (3, 5, 7, 13). These reoccurring measurements from the Y and X-axis also control the basic structure of the composition as frequency shifts, method for sound synthesis or change of filter banks.

3.3.2 Chaos switch

One of the switches on the thumb controller is implemented as a chaos switch. It is there to create a gap of an eventual linear comfort that might have been established during the performance. The chaos switch creates a certain amount of disorder in light and sound structure.

3.4 Exploring light as a material for performance

During my two month residency period I started to examine three different kinds of lights, electroluminescence wire, light emitting diodes, LEDs and optic fiber [19] Not only the quality

of light, as intensity of light and color, has to be taken into account but also the relation to the space where the performance is going to be.

Electroluminescence wire, a copper wire coated with a phosphorus material and wrapped with transmitter wires. Its brightness is determined by voltage and frequency.

Intensity of light from LEDs is measured in mill candela (mcd), where 1000 mcd equals 1 candela. [20]

Optical fiber is a reflective material. The type of light source used in optical fiber, generates intensity of light and color. In the development of the GO controller a LED of 22 candelas is used to implement light in the optic fiber.

Figure 4. User test with light and sound

3.5 First user test

The last week of January 2007, the first user tests was made of the prototype, with one set of light construction, made of mounted LEDs on plastic. First user test were made with a group of students at the Academy. Mariana Ferreira tested the prototype, without any previous knowledge of using the controller. A user test made by someone without previous experience, the controller is easy to use. As Ms Ferreira said, “the interface is not something to learn, but to explore”.

Figure 5. User testing the first prototype of GO.

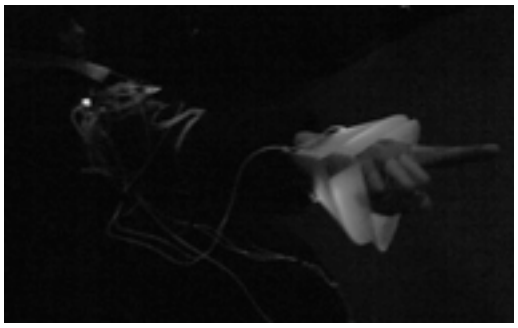

Figure 6. User testing as improvised performance.

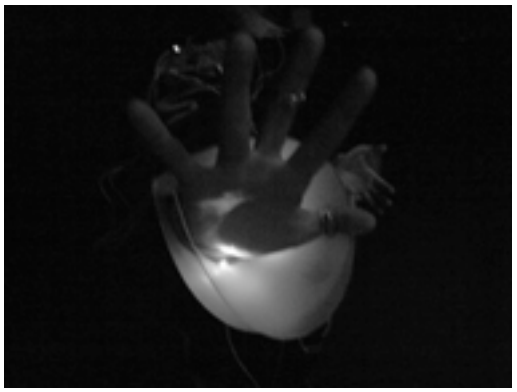

Figure 7. User testing by student Mariana Ferreira

Figure 8. User testing GO

4. CONCLUSION

After the first user tests of the controller, awareness of the explorative notion of performance has to be maintained in future developments. The link between sound and light has been explored by many but not in the form of wearable controllers. Examining light as visual expression in relation to real-time sound processing in performance with wearable controllers is an area that could be explored more. In this early stage of development the conclusion from user testing is that the GO controller is easy to use without previous experience. User testing also shows that sound processing is the driving force in improvisation, but a certain improvisational brake of attention occurs when the lights are visible to the performer. Not all lights are visible to the performer all the time, but only to the spectator.

5. FUTURE DEVELOPMENT

The next stage of development, is to explore more extensively the use of light as material in the design of interfaces for musical expression, and in parallel to that, develop the sound composition.

After a few more user tests of the controller, a wireless transmitter/receiver pair will be implemented into the design. For the final design, a Printed Circuit Board (PCB), will be developed in Eagle [21].

The GO controller will be tested live March 23 at Martin-Luther-Kirchengemeinde in Berlin, and April 6, at Make Art, festival of open source art, Poitier, France [22]

6. ACKNOWLEDGEMENT

I want to thank former Head of School Kristin Norderval and current Head of School Carle Lange at the Norwegian Theatre Academy at Østfold University College, Norway, for accepting my project. I also want to thank all staff and students for making my stay creative, and especially thanks to student Mariana Ferreira for user testing.

7. REFERENCES

[1] Iannis Xenakis works, especially Philips Pavilion with Corbusier, 1958, *Polytope de Montréal*, 1967, *Persepolis*, 1971, *Le Diatope* 1978. http://www.oswalt.de/en/text/txt/xenakis.html

[2] Ralph Lundsten work with *Andromatic*, 1966/67, a 10 tone generator and shift register for the sequencer, and the *Love Machine* or *DIMI-S*, 1972, a socially interactive controller is coupled with a light output. Both instruments developed with Erkki Kurenniemi. http://www.andromeda.se/studio/index.shtml

[3] Video can here be representing light and has been used by artist groups as LoVid in their work *VideoWear*, as wearable light and sound, http://www.ignivomous.org/projects/lovid/performances/southfirst/index.htm

[4] The Artist in Residency program is Nordic Resort, organized by the institute Nordscen serving under the Nordic Council of Ministers, http://www.nordscen.org

[5] Residency period was December 2006-January 2007 at The Norwegian Theatre Academy in Fredrikstad, Norway http://www.fig.hiof.no/

[6] Sjuve, Eva, Gestures, Interfaces and Other Secrets of the Stage, in *Proceedings Digital Art Weeks 06*, Zürich, Switzerland, http://www.digitalartweeks.ethz.ch/web/DAW/Proceedings06

[7] "Kinesis" controller developed in 2002. After one year of user testing in the UK, Germany, France, Denmark, and New York, a new board was developed in 2003, with the generous support from Swedish Performing Right's Society, STIM. http://moomonkey.com/Projects/kinesis.html http://www.moomonkey.com/Projects/13volts.html

[8] Cycling 74, http://www.cycling74.com/

[9] *Fake Radio*, http://moomonkey.com/Projects/fake.html

[10] http://www.jamesclar.com/

[11] http://www.cs.colorado.edu/~buechley

[12] http://www.eciad.ca/~dburg/main.htm

[13] http://www.moodvector.com/

[14]Microchip, http://microchip.com

[15] Analog devices accelerometer, www.analog.com/UploadedFiles/Data_Sheets/567227477ADXL202E_a.pdf

[16] Chadabe, Joel, *Devices I have known and loved*, Trends in Gestural Control of Music, IRCAM 2000

[17] Merleau-Ponty, Maurice, *Phenomenology of Perception*, Routledge: New York 1962

[18] Pure Data can be found at Miller Puckett's web site. http://crca.ucsd.edu/~msp/software.html

[19] This optical wire has a light effect across the whole wire, caused by a scattering of the elemental particles.

[20] Light emitting diodes (LED) explained at http://www.gizmology.net/LEDs.htm

[21] Eagle PCB development, http://www.cadsoft.de/freeware.htm

[22] The Nordic participants at Make Art in Poitiers, France is organized by Bergen Center for Electronic Art, Bergen, http://www.bek.no, Norway, supported by generous grants from the Norwegian Culture Council and Bergen Kommune.