Twenty-first Century Piano

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Abstract

"The reinvigoration of the role of the human body" - as John Richards recently described trends in using homemade electronics to move away from laptop performance [1] - is mirrored in an ambition of instrumentalists to interact more closely with the electronic sounds they are helping to create. For these players, there has often been a one-way street of the 'instrument feeds MAX patch' paradigm and arguments are made here for more complete performance feedback systems. Instrumentalists come to the question of interactivity with a whole array of gestures, sounds and associations already in place, so must choose carefully the means by which the instrumental performance is augmented. Frances-Marie Uitti [2] is a pioneer in the field, creating techniques to amplify the cellist's innate performative gestures and in parallel developing the instrument. This paper intends to give an overview of the author's work in developing interactivity in piano performance, mechanical augmentation of the piano and possible structural developments of the instrument to bring it into the twenty-first century.

Keywords: sensor, gestural, technology, performance, piano, motors, interactive

1. Introduction

There is currently much interest in how the piano might move forward in time. From practitioners such as Andrea Neumann [3] (see end picture 1), - who brought the inside of the piano out with the help of piano builder Bernd Bittman - through to piano builders such as Pierre Malbos with his Piano Baschet (see end picture 3), artists are attacking the cumbersome and revered nature of the instrument, whilst wishing to retain something of the renown beauty or mechanics of the instrument.

My own research works in several directions at once: separate strands that can be explored, each with its own context and history of research but able to be brought together into one overall project. An example from each strand is given here, with a brief description of their application in making more technologically integrated piano performances.

The first area of investigation is sensor technology (movement, light and now bio-sensors) in live performance. Secondly, augmenting the mechanics of the piano is briefly discussed with the addition of motors directly to the instrument and finally, why and how a possible re-structuring of the piano might be pursued, to better enable playing of the entire instrument using well-established contemporary techniques.

2. Performative feedback

The point at which acoustic instrumental performance meets technology throws up many questions. We are all familiar with traditional instrumental paradigms – I play this, you hear this. By adding electronic sound, this relationship is immediately complicated. I play this, you hear *this* but also *that* – which may or may not reinforce what was played acoustically. In live electronics, a performer's interaction with a computer has often been one of feeding the computer – the familiar instrument into MAX/MSP patch and electronic sound out of the speakers approach. Emmerson [4], Harris [5] and Rebelo [6] have all written eloquently on this subject.

This one-way street is not only limited but also creates separation of acoustic and electronic, producing potentially conflicting directions of the sources of sound. Of course, the performer can respond to what the computer does to their playing: adjusting dynamics, articulation, even tempo but the fact that the response is pre-programmed means these adjustments have limited power in really changing the resulting response.

The use of MIDI pianos has attempted to make this street two-way and back in the 80s Phillippe Manoury's Pluton [7] addressed this issue with success. So how can we take this two-way street further: to create a circular system where the piano feeds the processing and in return, the processing feeds the pianist's physical gesture – by allowing the processed sounds to be manipulated by the pianist, for example through the use of sensors. The point here is that pre-composed responses can still be written but the final interpretative moment and subtlety rests with the instrumentalist: 'Prospero-like, the individual performer might in practice control all aspects of the piece from the largest to the smallest, both local and field' [4]. This vision works on the traditional instrument paradigm, proved over hundreds of years to be a powerful communicative mechanism and it was with these thoughts that I began to look at developing the pianist's 'performance environment'. Although I have commissioned several pieces considering this[1] here I have limited my examples to those that use sensor technology.

3. Sensor work

The first example given here is a piece by Jonathan Green [8], using light sensors inside the instrument and a webcam on the side of the keyboard (see Figure 1).

Figure 1. Piano & Lamp set-up

Using a lamp clipped to the instrument, the pianist first interacts with the webcam by gesturing towards and away from, into and out of its field of vision. This activates the webcam to trigger pre-recorded samples. Later, the lamp is picked up by the pianist and used to light up the inside of the piano to activate two light sensors placed inside.

This theatrical treatment of the instrument, which acknowledges and explored the inside of the piano so imaginatively, gives the instrumental performer the chance for a similar relationship with the computer sounds as with their instrument – tactile, gestural, physically immediately responsive. What is dramatically communicative is the relationship of light, gesture and sound and the very real-time responsiveness of the system.

The second piece by Green referenced here was part of an AHRC-funded project[2] into extending the repertoire for piano and live electronics. This piece[3] used accelerometers on each hand (other sensors such as a flex sensor on the right elbow and a compass 3D sensor, which read position relating to a calibrated point were rejected as too complex for the amount of time available) with the research question being 'how can we meaningfully map pianistic gesture to processing?'. We established a research method to collect data: making films of my playing specific notated gestures on the piano whilst wearing the sensors. In this way, visual and sensor information data was captured in a measurable way, to allow notational and gestural events to be compared.

The aim here was to create total harmony between pianistic gesture, sound and resulting electronic sound so the system was kept simple: the accelerometers were controlling the pitch bend of the live sound produced at that exact moment. The result was an instinctive and intuitive system mapped to innate pianistic gestures, which were simply amplified to create more 'effect'. However, it was also discovered that the gestures were so innate that audiences often found it hard to perceive how the sensors affected the sound.

3.1 Hat sensors

The next sensor investigations were therefore deliberately made much more obvious. The example here is given from work with a group of programmers[4] from the Centre for Digital Music research centre at Queen Mary's, University of London [9] (the research was hosted by PianoLab - an accumulative research space enabling easier access to pianos and computer technology in one working space).

After discussion, it was decided to place the sensors in a hat, as this would enable both independence of pianistic gesture from processing control and also add an element that could be used to explain more theatrically what was being heard – the relationship between live piano and computer processing.

The sensor used was the icube *Gforce 3D-3 v1.1,* which 'senses dynamic acceleration (or deceleration) and inclination (tilt, ie. acceleration due to gravitation) in three dimensions simultaneously'[5]. The precise position data from the sensor allowed detailed control through tilting the head at different angles, following trajectories and making sudden movements to create acceleration data. As a device for a pianist it worked well – leaving all other elements of the pianists' technique untouched but displaying the interactivity to the audience by the most visible, perhaps most demonstrative part of the body. We worked to map the processing so the sounds were communicatively embodied in character or range by the gestures.

3.2 Bio-sensors

Taking the idea of physically entwining processing control and piano playing, the next example is of work with another icube sensor, the *bio-flex 50 v1.1*. The question here is: how much is it really possible to use muscles to enact two different yet inseparable control functions? With the webcam and the hat, the pianism and processing control can be separated; conversely, with the accelerometers placed on the hands, the gestures of piano and computer control are innately linked. The bio-sensors give a new challenge: the muscle movements needed to give data to the sensors are almost anti-pianistic – to get

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[1] For example pieces by Larry Goves, Pierre Alexandre Tremblay

[2] Other commissions from Professor Richard Barrett, Professor Michael Clarke, Reader Michael Edwards, Larry Goves

[3] Green. J. *Into Movement* (2008) Available from the composer

[4] Adam Stark, Andrew Robertson, Kurt Jacobsen, Samer Abdallah; commissioned by Nick Bryan-Kinns

[5] Infusion systems, Accessed 10 April 2009 <http://infusionsystems.com/catalog/product_info.php/products_id/157>

the strongest readings, Professor Atau Tanaka[6] has already discovered over several years that they require tension either extending certain digits or an almost 90 degree flexing back of the hand (see figure 2). Researching this with Tanaka, initial studies were made into whether notes on the piano could be activated in a subtle enough way whilst also activating the sensors. The findings so far, are

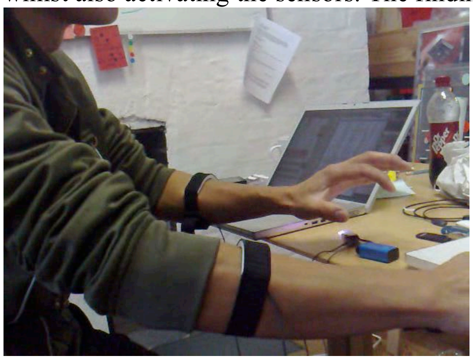

Figure 2. Atau Tanaka demonstrates the bio-sensors

that the system becomes a kind of conversation between the pianistic movements and the sensor-related ones, with this poetic relationship giving the impression of an almost breath-like quality to the playing.

4. Augmenting the instrument

Whilst examining methods of interaction with electronic sound, parallel investigations were made to examine possible augmentations of the mechanics of the piano. This was for two reasons: if the resulting sound was being amplified by electronic responses, why not make these electronic responses also control acoustic results and secondly, if we were looking at augmenting the pianist's control of processing, why not also attempt to augment the direct playing of the instrument.

Motors were chosen as easily controllable electronic devices and starting with small motors, the initial phase of this work was undertaken with Will Scrimshaw[7] who wired an Arduino board to nine normal DC motors and one gearhead motor (see figure 3). The motors were initially programmed in Supercollider to run only in pre-set routines and also to respond to a live FFT analysis of the piano. The effect of the latter produced interesting results, creating a perpetually self-playing system: quickly accumulative – motors hearing their assigned frequencies constantly firing – an interesting application was found using two pianos: by using the sound of one piano as a remote control (sending microphone information to the computer) we could activate the motors playing another piano.

Pursuing more exact control by the performer, with the team from Queen Mary's, more precise control functions - such as start, stop and speed control - were

Figure 3. DC motors in the piano.

established using a standard MIDI interface. Extensive work on scales of predictability previously undertaken by Samer Abdallah was also used to create a library of rhythmic patterns for the motors. A bank of a total of ninety-nine patterns thus allowed the performer to move through a quite extensive score, with increasing levels of unpredictability built in[8].

5. Re-structuring the Piano

Playing inside the piano has been notated from the early twentieth century with early famous examples being *In a Nutshell* (1916) by Grainger and *Aeolian Harp* and *The Banshee* (1923, 1925) by Henry Cowell. Despite the quite frequent call by composers since - and especially currently - for pianists to access the inside of the instrument in some way whilst playing (Crumb, Kagel, Orff, Takemitsu, Wolfgang Mitterer, Richard Barrett to name only a few), the physical discomfort and logistical difficulties of this has not been significantly challenged by commercial piano makers. The problems begin with the obvious discomfort of standing up and leaning inside the instrument and extend to more subtle issues such as trying to pedal, maintaining any kind of pianistic relationship with the keyboard (ie with one's arm at the correct angle), being unable to still read the music from the stand in its intended position. Further layers of this problem are that technically it is difficult to reach very far into the instrument and even more importantly perhaps, the complete disassociation for the audience from the playing – as if the pianist is 'disappearing under the bonnet of a car'[9].

Thinking about how best to tackle the main issue of wanting to access both the strings and the keyboard at the same time, my research led to deciding to up-end the piano (see Figure 4), and in doing so, reverting to an old piano shape such as the Giraffe piano. The issues mainly concern having to revert to having to use an upright piano action – seemingly a step backwards – and also understanding the acoustic changes. Initially it seems that the instrument actually projects more effectively, as the

[6] Chair of Digital Media and Director of Culture Lab, a research centre at Newcastle University, UK

[7] A PhD student at Culture Lab, Newcastle University

[8] A paper written by the team from the Centre for Digital Music and Sarah Nicolls has recently been submitted to the Leonardo Music Journal: 'Who's in charge? Interaction in Performance'.

[9] A comment made to me after a concert.

soundboard is directly facing the audience. What is key – and crucially different to existing upright pianos - is that the strings are above the keyboard, allowing easy access.

From an interactivity perspective, advantages are the audience being able to see gestures clearly and the gestures to be unhindered by logistical issues. Being able to access the keys and strings at once opens up the potential for the development of existing techniques and for a new gamut of techniques with string- and key- play interaction.

Figure 4. Newly structured instrument

6. Future developments: PianoLab

Designed as an accumulative research space, the PianoLab will run for set periods of time (minimum one month) in different countries before hopefully finding a long-term home. The very nature of the immobility of pianos is one of the driving forces for researching new options of structural design but meanwhile, pianos remain huge unwieldy pieces of furniture. The PianoLab resource provides an invaluable space where instruments and programmers can co-exist research with real-time investigative methods. A comparable model is Uitti's Augmenting the Cello project, hosted at CNMAT in 2006 [10]. It is also the accumulative nature of the space that is crucial – each development is there to be further explored by the next collaborator, thus creating a fertile research framework. This has already been proved by several phases of the lab, creating a sense of momentum. In my next research project we will also build a professionally regulated piano on the same structural lines, also incorporating MIDI elements.

7. Acknowledgments

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References

[1] Richards, J. "Getting the hands dirty", *Leonardo Music Journal* , vol. 18, pp. 7-8, 2008.

[2] Frances-Marie Uitti, Accessed 15 Jan 2009, <http://www.uitti.org/>

[3] Andrea Neumann,15 Jan 2009, <http://www.japanimprov.com/profiles/aneumann/>

[4] Emmerson, S. 'Local/field': Towards a Typology of Live Electroacoustic Music", in Proc. of the International Computer Music Conference: The Human Touch (ICMC), 1994, pp. 31-34.

[5] Harris, Y. (2006). Inside-out Instrument. *Contemporary Music Review Vol. 25, No. 1/2, February/April 2006,* pp. 151 – 162

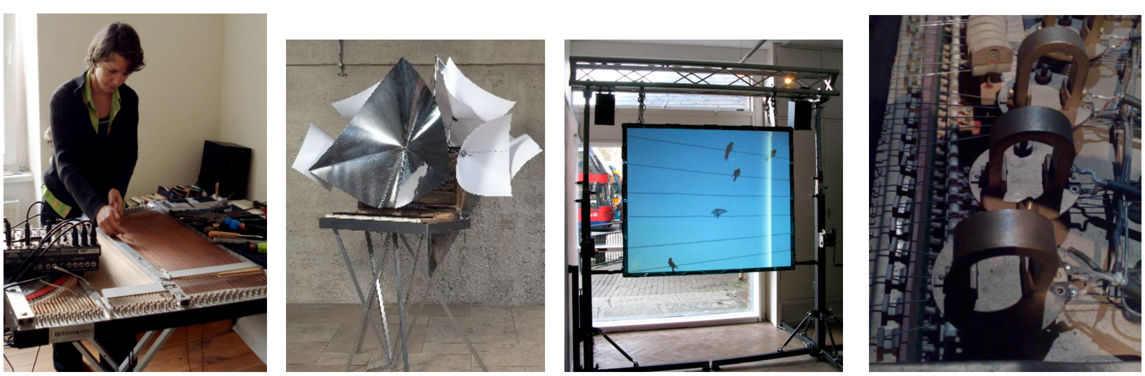
[6] Rebelo, P. "Haptic Sensation and Instrumental Transgression", Contemporary Music Review **25**:1/2, (Feb/Apr 2006), pp. 27 – 35

[7] Philippe Manoury, 15 Jan 2009, <music.ucsd.edu/faculty/>

[8] Green. J. *Piece for Piano & Lamp* (2005) Available from the composer, currently based at the Centre for Life Sciences, Cambridge

[9] Commission for (re)Actor (BigDog Interactive) given by the Centre for Digital Music at Queen Mary's, Univ. of London <http://www.elec.qmul.ac.uk/digitalmusic/>

[10] Zbyszyński M. "Augmenting the Cello" (Freed, Adrian, Francis-Marie Uitti, and Michael Zbyszyński: NIME Paris 2006)



End pictures: 1. Andrea Neumann with her 'inside piano'; 2. Piano Baschet-Malbos by Pierre Malbos; 3. Kathy Hinde's installation piano, using motors synced with projections; 4. Neo-Bechstein (piano made in the 1930s): close-up of pick ups