Music Controllers & Tabletop Tangible Interfaces for Multithreaded Musical Performance: the reactable

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When asked what musical instrument they play, few computer musicians respond spontaneously with ”I play the computer.” Why not? (Wessel & Wright 2002).
Talk Structure

- Computer Music Performance & Music Controllers
- The reactable and tabletop user interfaces
Live Computer Music & Music Controllers

- The computer is everyday more ubiquitous in music, not only in reproduction, production or postproduction, but also as a tool for live performance...
- We all know the mouse is not well suited for real-time multi-parametric control...
- Many new interfaces for musical expression (NIME) are being invented...
What is NIME?

The International Conference on New Interfaces for Musical Expression is currently in its 7th year. Researchers and musicians from all over the world gather to share their knowledge and late-breaking work on new musical interface design. The conference started out as a workshop at the Conference on Human Factors in Computing Systems (CHI) in 2001. Since then, international conferences have been held around the world, hosted by groups dedicated to research on New Interfaces for Musical Expression.

Proceedings of all NIME conferences to date may be conveniently navigated using the pages at the University of Trier’s DBLP resource, or at the ACM Portal. The DBLP and ACM Portal also provide BibTeX entries for the papers, useful when citing work published at NIME.

If you are interested in hosting a NIME conference, please consult the hosting NIME page.

Click here for the current annual NIME conference homepage.
Hugh Le Caine’s electronic sackbut (1945-1973)

1. 1948 “clarinet” (Rapshody in Blue)
2. 1948 “mutted trombone” (playing with formants)
Music controllers & MIDI

- Despite MIDI being extremely key-oriented, MIDI also made simpler the creation of new controllers (early 80s)

- Wanderley (2001) classifies
  - instrument-like controllers (imitate)
  - extended controllers/hyperinstruments (expand)
  - alternative controllers

- Commercial controllers tend to imitate trad. Instruments (at least until the mid-2000s)

- Paradiso (1997) further classifies alternative controllers into:
  - Batons
  - Non-contact (incl. Theremin-like, cvision, ultrasound...)
  - Wearable
Controllers: The sunny side

- Music controllers can preserve traditional playing modes, permitting us to blow, strike, pluck, rub or bow our ‘computers’
- New traditionalists in turn, may prefer to continue clicking, double-clicking, typing, pointing, sliding, twirling or dragging and dropping them
- With the appropriate sensors, new digital instruments can also be caressed, squeezed, kissed, licked, danced, hummed or sung
- They can even disappear or dematerialize while responding to our movements, our muscle tension or our facial expressions
Michel Waisvisz’ The Hands (left up)  
BioMuse (Brainwave detector!) (left mid)  
Donald Buchla’s The thunder (left down)  
Sergi Jordà’s LowTech-QWERTY Caster (cent down)  
Max Mathews’ Radio Baton (right down)  
Videodetection with Very Nervous System, David Rockeby (right up)
How much a human is able to control meaningfully?

What about practicing & mastering?!
Controllers: The dark side

Many new interfaces for musical expression (NIME) are being invented... but the laptop+NIME convergence seems yet reluctant ...
Controllers: The dark side / coupling & mapping

Acoustic instruments rely on the law of mechanics and the separation between controller and sounding body does not exist (except perhaps in some keyboard instruments - e.g. organ)
With the flexibility offered by MIDI, any controller can certainly be combined with any sound- and music-producing device. Still, each choice is critical. As pointed out by Joel Ryan, improviser, leading researcher in the NIME field and technical director of the Dutch laboratory STEIM, ‘a horizontal slider, a rotary knob, a sensor that measures the pressure under one finger, an accelerometer which can measure tilt and respond to rapid movements, a sonar or an infrared system that can detect the distance between two points, each have their idiosyncratic properties’ (Ryan 1991).

Any input device can become a good or a bad choice depending on the context, the parameter to control, or the performer who will be using it. Just as the automotive engineer chooses a steering wheel over left/right incrementing buttons, ‘we should not hand a musician a butterfly net when a pitchfork is required’ (Puckette and Settel 1993). The challenge remains how to integrate and transform this apparatus into coherently designed, meaningful musical experiences with emotional depth.

It is in fact extremely hard to design highly sophisticated control interfaces without a profound prior knowledge of how the sound or music generators will proceed; a parallel design process will surely be more enriching than buying the ultimate controller for plugging into any custom software.
Human vs. non human (a) excitation energy and (b) process automation in acoustic and electric instruments
Shared Responsibility

One of the best assets of new digital instruments is the possibility to run several multiple and parallel musical processes in a shared control between the instrument and the performer. The performer is not controlling all the parameters, all the time.
Multithreaded and shared computer music performance (MSCMP)

Jeff Pressing (1990)
- playing a musical instrument
- conducting an orchestra
- playing together (ensemble) with a machine
- acting as a one-man band

MSCMP systems (instruments) also tend
- to surpass the one gesture to one acoustic event’ paradigm
- go beyond the sound and note control level
“Traditional” Music Controllers ?!?!?

- Michel Waisvisz’ The Hands (left up)
- BioMuse (Brainwave detector!) (left mid)
- Donald Buchla’s The thunder (left down)
- Sergi Jordà’s LowTech-QWERTY Caster (cent down)
- Max Mathews’ Radio Baton (right down)
- Videodetection with Very Nervous System, David Rockeby (right up)
tend to be worn and played all the time
take little profit of computer displays
Some personal and empirical guidelines (Jordà 2005)

- **Return & low-dim control** is preferred for micro-control (e.g. timber nuances) (conceptually closer to acoustic instruments) (Le Caine!)
- **Hold & high-dim control** is preferred for macro-structural control (typical of Interactive Music Systems)
- Space multiplexing is preferred for real-time interaction
- **Always on** controls (e.g. position in space) should be avoided, or used with very simple and affordable secondary buttons (i.e. scarce use of time-multiplexing)
- “Too much [visual] feedback” does not exist (but bad [visual] feedback does!)
- When running multiple and parallel musical processes in a shared control between the instrument and the performer, the possibility to have **multiple performers** seems as a logical and promising extension
Non-traditional, “multithreaded”, Music Controllers

- It is the screen and not the mouse what laptop performers do not want to miss!
- That’s where tabletop interfaces appear!
reactable
reactable live performance
Barcelona, November 2007
... and professionals
collaborative
The reactable wants to be ...

- The “right-brain tool” for computer music
- Intuitive, immediate access (public installations, kids, no instructions....)
- Explorative & “infinitely” complex, but not intimidating
- Learnable, masterable and suitable for virtuosity (concerts)

[toy vs. complexity, low level, full control, impro with no presets]
The reactable goals and design principles

- The reactable starts from a musical concept, and not as a potential demo of a given technology
- The reactable was designed with the best of two worlds in mind
  - from traditional music instruments,
    - it allows simultaneous and multi-parametrical control using both hands (even with multiple users)
  - from computer music software,
    - it gives complete visual feedback of
      - all current users’ actions, and
      - all ongoing computer-controlled musical processes
Influences
Introducing the reactable

- Is a computer-based electronic music instrument musical, with a round tabletop interface (no leaders, no privileged position)
- It is inspired in 1960s modular synthesizers, such as the ones invented by Bob Moog
- It is a multi-user instrument, which can ideally be played by several simultaneous performers

- It has been in development since 2003 at the Music Technology Group in the Pompeu Fabra University in Barcelona (Sergi Jordà, Günter Geiger, Martin Kaltenbrunner & Marcos Alonso)
Tabletop Interfaces are promising

- Promote user collaboration
- Allow two-hand manipulation and “infinite” simultaneous pointers
- Provide ample room for organising objects
- Physical objects can be more than just input devices, they can combine control and representation, maximizing bandwidth and minimizing indirection
How does it work?

[1] Connectivity
Visual Feedback

• All what is relevant is shown
• All what is shown is relevant (WYSIWYG ⇒ AWIRISAWISIR)

• No widgets, no wimps, no text, no numbers, no decorations
## Objects’ Types

<table>
<thead>
<tr>
<th></th>
<th>Connections</th>
<th>Shape</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Generators | 1 audio out  
            | N control in | □       | square wave  
                          |                        |                     | sampler player    |
| Audio filters | 1 audio in  
                            | 1 audio out  
                            | N cntrl in | resonant filter  
                          |                        |                     | flanger            |
| Controllers   | 1 cntrl out | □       | sine wave low frequency oscillator  
                          |                    |                     | 12-step amplitude  
                          |                        |                     | sequencer          |
| Control filters | 1 cntrl in  
                             | 1 cntrl out | □       | decimator  
                          |                        |                     | sample & hold      |
| Audio mixers | 2 audio in  
                             | 1 audio out  
                             | N cntrl in | mixer bus  
                          |                        |                     | ring modulator     |
| Global       | N cntrl in | □       | metronome  
                          |                        |                     | tonalizer           |

Table 1. A summary of the reacTable objects types
square objects are sound generators (here, a square wave oscillator)
How does it work [2] Technology diagram

- Projector
- Camera
- Visual synthesizer
- Audio synthesizer
- ReactIVision
- Connection manager
- Tangibles tagged with fiducials
How does it work [3] Tracking

We have developed our own fiducial tracking system (reacTivision), optimized for 2D fast & robust tracking.
How does it work [3] Tracking: reacTIVision

- Developed at MTG-UPF Barcelona, by Ross Bencina and Martin Kaltenbrunner for the reactable
- Tracks 100s of different objects (with visual markers), detecting their position and orientation
- Tracks fingers (pointing, drawing, cutting flows, marking ...)
- Up to 60 fps (and faster depending on the camera)
- Calibrates projection and corrects distortion
- Modular approach + UDP com. promote remote collaboration & integration with other devices (e.g. portable...)
- Available as open-source http://www.iua.upf.es/mtg/reactable/?software
The reactable also allows remote collaboration
almost 4 million views on YouTube and 2,000 blog posts
KEYBOARD OF THE MONTH
THE REACTABLE

Last year, Björk saw a YouTube clip of someone playing a strange instrument. The device triggered electronic sounds by moving blocks around on an illuminated table. Intrigued, she flew to Paris to meet with the designers of the invention, called the Reactable. After about thirty minutes, she said, “I’m taking this one.”

Sergi Jordà, who developed the Reactable with a team at the Pompeu Fabra University in Barcelona, told Björk about its control system. She didn’t let Björk steal his contraption, since there were only two in the world. He built one for her tour, and they eventually made another.

The Reactable takes information on its surface, including its ring of lights that translates it into sound using software that runs on a PC or directly to speakers. The Reactable is the blocks placed on top of it on a table that scans patterns and produces sounds. The degree of rotation determines the pitch, and their location governs which speakers the sound emanates from.

The square blocks generate sounds or samples. Their degree of rotation determines the pitch, and their location governs which speakers the sound emanates from.

The ultimate in audience participation, Reactable makes music easy, visual and literally child’s play.

Hands on: REACTABLE

which also alters the pitch of the sound. Like keys on a keyboard, different combinations of objects produce different sounds – but it is the Reactable’s visual aspect that makes it so appealing. When played in the dark, the table’s one-metre-square surface glows luminously, and the flow of sound between the objects is visualised. Uniquely, users see the sound that they are producing, which has attracted both the attention of children and something that has added a dash of cool to computer science. ReacTable at London’s Optronica festival in March. “When there are too many kids playing for the first time, they lose control.”

Jordà, an award-winning computer scientist with “noisy and experimental” music, says he didn’t expect the feedback on the table’s applications in education. “The Reactable is also a way to engage children in creating sound – to build something that adds a dash of cool to computer science.”

dozens of magazines
from Rolling Stone to Dazed & Confused
Hottest Music Biz Start-Up Award (MIDEM, Cannes, January 2008)
Premi Ciutat de Barcelona, Multimedia (February 2008)
Premi BMW a la Innovació (Barcelona, March 2008)
2 D&AD Design Awards (London, May 2008)
Golden Nica / Digital Musics, Ars Electronica (Linz, June 2008)
Permanent exhibitions:
- Cosmocaixa Madrid
- Montreal Science Center (CAN)
- Laboral Centro de Arte, Gijón
- Museum of Science and Industry, Chicago (IL)
- Discovery World, Milwaukee (WI)

Soon: Athens, México City, L.A., Barcelona, Tokyo ...
80 concerts and public installations in 25 countries (2007)
Björk at *Later with Jools Holland*
BBC, June 8, 2007
NYC "United Palace Theatre", May 5th 2007
Success? Why?

- It looks cool and we’ve been lucky...
- But... is there something more?

- It is magical, beautiful, sexy, simple... & yet, it seems to work!
- Non-intimidating and inviting, no need to understand it in order to get seduced...
- ... Yet, understanding comes by itself, with no hurry...
- Its immediate multimodal richness seems enough for unlimited exploration ("autistic")
- Although inspired in modular synthesisers, what it does, cannot be done with anything else (ie. the sonic results have been heard before, but the way to interact with them are completely new and times easier)
reactable on the market?
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Thank you!

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