Design: music controllers

Acoustic vs. electronic instruments

* Acoustic instruments
  • Sound source and interface are the same artifact
  • Nature of expected sound & laws of physics dictate the instrument’s form and how it is designed
  • Fixed and relatively transparent mapping
  • Acoustic + haptic feedback
Design: music controllers
Acoustic vs. electronic instruments

* Electronic instruments
  • Sound source and interface separated → mapping, interaction and physical attributes are free
  • Need for methods and constraints in order to fulfill criteria of expressiveness, transparency, audio quality
  • Need for feedback

Design: music controllers
Issues

* Purpose of design
  Users
  Experts vs. amateurs?

* Uses
  Composition? Performance? Education? Cognitive stimulation?

* Designing an…
  Interface? Instrument? Composition tool?
Design: music controllers

Issues

* Criterias
  • Relationship between performer and audience
  • Physical effort
  • Complexity / transparency
  • Ergonomics
  • Cultural context

It is not just about producing sound, it is about the whole experience of producing sound

Design: music controllers

Interaction loop

* Simplified model
Design: music controllers

Interaction loop

* Simplified model

input  interface  mapping  sound generator  output

1rst fb
2nd fb

Design: music controllers

Interfaces

* Object-based
Starting with existing instruments
- augmented (hyperinstruments…)
- digitalised (ex: piano synth)
- interface used as controller (ex: MIDI keyboard)
Use metaphor of object

Taku Lippit, ITP/NYU, 2002-03
Machover & Ma, Hypercello, MIT, 1991
**Design: music controllers**

*Interfaces*

* Object-based

Repurposed everyday objects and materials: water, fabric, chemicals, vegetables …

**Design: music controllers**

*Interfaces*

* Object-based

Take advantage of the material properties of objects f.e.x bendable, conducts electricity, etc

Take into consideration human activities surrounding the objects: build upon it and / or break from it
Design: music controllers
* Body-based
Human body as start for design

Music controllers
* Body-based
Human body as start for design: Expressive qualities of human movements
**Design: music controllers**

**Interfaces**

* Body-based

Human body as start for design:
- Ergonomics
- Existing gestures
- Expressive qualities of human movements
- Scale and continuity of movements

* Environment-based

Interactive environments
- Reactive floors
- Digital realm: networked audio
Everyday environments, etc

---

Magic Carpet, MIT Medialab, 1996
Global String, Tanaka & Toeplitz, 1998
Sonic City, Gaye et al., 02-04
Design: music controllers
Interfaces

* Environment-based

Take advantage of the features of space

- Interactive environments:
  many people together, control of interaction parameters…

- Everyday environments:
  rich environment, unpredictable, dynamic, heterogeneous

Design: music controllers
Interfaces

* Wearables
Musical jeans jacket
(MIT Medialab, 1992)

Tgarden
(FoAM & sponge, ~2001)

Expressive Footwear
(MIT, 1997-2000)

ensemble (Kristina Andersen, ~2003)
**Design: music controllers**

* Interfaces

- **Wearables**

  Intimate interfaces
  Body movement and posture
  Theatrical vs. daily life dimensions

* Representations

  - Tangible algorithms
  - Virtual instruments
  - Screen-based (laptop musicians using MAX/MSP, Pd, etc)
Design: music controllers

Interfaces

* Representations

Taking familiar sound manipulation metaphor and making it tangible, into space.

Design: music controllers

Interfaces

* Circuit bending

Hacking is fun!

Modified Toy Orchestra
Design: music controllers

Interfaces

* Hybrids
Controlling e.g. audio and visuals together
Balancing and adapting interaction so that both dimensions are satisfactory

Design: music controllers

Interaction loop

* Simplified model

```
input → interface → mapping → sound generator → output
```

1st fb
2nd fb

control
Design: music controllers

Control

Levels of indeterminancy
• Control vs. randomness (→ interactive improvisation)
• Total predeterminancy: push a button → deterministic output
• Total undeterminancy: random machines
• Unexpected vs. expected input / output

Control characteristics
• Continuous vs. discrete control
• Implicit vs. explicit
• Micro- to macro-level control: sound spectrum to details of articulation to overall structure

Design: music controllers

Interaction loop

* Simplified model

input → interface → mapping → sound generator → output

1st fb
2nd fb
Design: music controllers

Mapping

* Issues

  • Complexity to stimulate creativity
  • Transparency to keep link between input and resulting sound (otherwise, danger of losing the audience)

* One-to-one

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<th>input</th>
<th>mapping</th>
<th>output</th>
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• Each independent input assigned to one musical parameter
• Simplest mapping scheme, but usually the least expressive
**Design: music controllers**

**Mapping**

* One-to-many

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- One input controls more than one simultaneous musical parameter
- Conductor model: provides a macro-level expressivity control, but does not allow access to internal (micro) features

* Many-to-one

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- Many inputs coupled to produce one musical parameter
- Requires previous experience with the system in order to achieve effective control
- But far more expressive than the simpler unity mapping
Design: music controllers

Mapping:

* Many-to-many

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- Many inputs coupled to many musical parameters
- Control on different levels

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**Definition:** Musical values, or statistics computed on inputs.

**Examples:**
- Computer inputs like button presses or mouse movements
- Inputs from game controllers
- Feature vectors computed on audio picked up by a microphone (e.g., describing timbre or pitch)
- Features computed from a webcam (e.g., describing overall brightness, location of yellow-est pixel)
- Anything else that can be sensed in real-time

**Parameters**

Definition: The model outputs real numbers or integers that can be used as parameters to control a sound synthesis algorithm or other real-time process.

**Examples:**
- Audio synthesis (e.g., in given programming languages)
- Looping, effects, or other processing in an audio program (e.g., Ableton Live)
- Animations (e.g., in Processing)
- Character or environment control in a game engine (e.g., Unity 3D)
- Robots, environmental control, ... Anything else that can be controlled in real-time

---

**Features**

The model models the relationship between input features and output parameters. A machine learning algorithm allows a user to implicitly specify this model by supplying examples of features & corresponding parameters during training.
Design: music controllers
Interaction loop

* Simplified model

Design: music controllers
Feedback

Feedback
• Helps articulating control
• Passive vs. active
• From mono- to multi-modal (modalities: audio, haptic, visual)
• 1rst FB: from interface
• 2nd FB: audio

Feedforward
• Guides user by providing information about the internal state of the system (as opposed to information from output)
Design: music controllers

Interaction loop

* Simplified model

input  interface  mapping  sound generator  output

1rst fb

2nd fb

Design: music controllers

Output

* Mechanical
Guitarbot
(Eric Singer et al., LEMUR, 2003-)

* Tactile output (haptics)
Cutaneous Grooves
(E. Gunther, MIT Medialab, 2001)
**Design: music controllers**

**Output**

* Alternative speakers
  - Soundbug™ speakers & piezos
  - Spherical speakers (Curtis Bahn)
  - Flower Speakers (LET’S corporation, Japan, 2004)

**Design: music controllers**

**Interaction loop**

* Simplified model

```plaintext
input → interface → mapping → sound generator → output

1rst fb
2nd fb
```

General forms of interaction
**Design: music controllers**

**Interaction**

* User movement
  - Choreographed body movement
  - Traditional instrumental gesture
  - Novel gestures

Design: music controllers

Interaction

* User movement
  - Full-handed gesture
  - Empty-handed gesture

+ Unvoluntary movements, embodied actions...

Design: music controllers

Interaction

* User movement
  - Full-handed gesture

Design: music controllers

Interaction

* User movement
  - Full-handed gesture
Design: music controllers
Interaction

* Real-time music
Improvising new music

vs. interpreting existing one
(conductor model)

vs. navigating through non-linear musical narratives

Radio Baton, Max Mathews, 1987

Design: music controllers
Interaction

* During performance
Interaction with environment, audience, etc

- Performer-performer
- System-audience
- Performer-system-audience

Tooka, Fels et al, UBC, 01-03
Crackle-family, STEIM, 1976
Dialtones, Golan Levin, 2001
**Design: music controllers**

*Interaction*

* During performance

- Audience as collaborative performer

- Private performances in public spaces
  …or over the internet

---

**Interfacing with sound:**

**Performance/installations vs everyday use**
Properties of sound in everyday life

- Ubiquitous (sometimes obtrusive)
- Dynamic and transient
- Broad yet subtle information carrier (emotions, data)
- Socio-cultural meaning
- Strong link to space and time
- Physicality (body and space)
- Additive: layers
- Foreground vs. background awareness -> implicit vs. explicit interaction

Sound in everyday interactions
Audio as input

Examples from art & research

Blendie
(Kelly Dobson, MIT Medialab, 2003-04)

Context Photography
(FAL, Viktoria Institute, 2003-04)

-> physicality, cultural meaning…
Sound in everyday interactions
Outputing sound

* Ambient audio displays
  - Street crossing auditory displays etc
  - Sonification of network activity: AmbientROOM
    (Hiroshi Ishii et al., MIT, 1996-97)

-> Peripheral awareness

Mobile music and locative audio
Mobile music and locative audio
Locative audio in public space

* Motivations
Sound as public display
Peripheral awareness
Community re-appropriation of public space

* Space annotation
Hear&There
(Rozier, MIT Medialab, 1999)

Tactical Sound Garden
(Mark Shepard, 2004)

Tejp / Audio tags
(PLAY & FAL, 2003-04)
Mobile music and locative audio
Locative audio in public space

Key Chain Radio Station
(Rikako Sakai, Ivrea, 2004)

Mobile music and locative audio
Locative audio in public space

* Radio pirates:
sensing environmental factors

Bit Radio
(Bureau of Inverse Technology)
Music technology meets mobile computing. Devices used anywhere, with awareness of place, in distributed / ad hoc networks…
Device follows user’s displacement and connects to the world (physical, social, located virtual)
- Mobile music making, listening, sharing
- Wearable audio
- Sound walks, etc

Mobile music and locative audio
Mobile music Technology

* Mobile music sharing

Social aspect of mobile computing: ad hoc networks, distributed social networks, etc
-> spontaneous and situated music sharing with people in public space
Mobile music and locative audio

Mobile music

* Mobile music sharing

SoundPryer (Mattias Östergren, Interactive Institute, 2001)

TunA
(Arianna Bassoli et al., Medialab Europe, 2002)

Push!Music (Håkansson et al., Viktoria Institute, 2005)

Mobile music and locative audio

Mobile music

* Mobile music sharing

Bass Station
(Mark Argo & Ahmi Wolf, ITP/NYU, 2003)
Mobile music and locative audio
Mobile music

* Mobile music making

Music making away from computer screen or performance setting: in the everyday
Sensor technology + GPS -> situated music making
Ad hoc & distributed networks throughout the city -> collaborative music making
etc

Mobile music and locative audio
Mobile music

* Mobile music making

Sonic City
(Gaye et al., FAL & PLAY, 2002-04)

Malleable Mobile Music
(Atau Tanaka, Sony CSL, 2004)
Mobile music and locative audio

Mobile music

* Mobile music making

Sound Mapping
(Mott et al., Reverberant, 1998)

Sonic Interface
(Akitsugu Maebayashi, 1999)

Mobile music and locative audio

Mobile music

* Mobile music making

CosTune
(Nishimoto, ATR, 2001)

Sound Lens
(Toshio Iwai, 200?)
Mobile and locative sound
"Walking through sound" (D. Toop)

* Sound-art installations
  Electric walks
  (Christina Kubisch)
  Drift
  (Rueb)
* Walking through digital space
  Seven Mile Boots
  (Beloff et al., 2003-04)
* Non-linear audio narratives
  The Case at Kulturhuset (Knifeandfork, 2004)

Mobile and locative sound
Wearable audio

"Personal instruments"
(Krzysztof Wodiczko, 1969)

(Chelle Hugues, RCA/CRD, 2000)
Mobile and locative sound
Wearable audio

Nomadic Radio
(Nitin Shawney, MIT Medialab, 1998)

Sonic Fabric
(Alice Santaro, 2002)

Design: music controllers
Issues

* Criterias
  • Relationship between performer and audience
  • Physical effort
  • Complexity / transparency
  • Ergonomics
  • Cultural context

It is not just about producing sound, it is about the whole experience of producing sound