NIME 2011 Tutorial

NIME Primer
- A Gentle Introduction to Creating New Interfaces for Musical Expression -

Sidney Fels
University of British Columbia
Michael Lyons
Ritsumeikan University
Laptop Performance
A NIME Performance
What is NIME about?

The Problem:

• Digital Technology & computers involved in nearly all forms of contemporary music

• But the computer is not a Musical Instrument

The “Office Gesture”

Laptop Battle Tokyo
Superdeluxe Roppongi
11/2008

© sml!
How to Play the Computer?

- Computers offer a wide range of sound and music creation opportunities
- How can we create new interfaces to play computers in a way that is appropriate to human brains & bodies?
How to Play the Computer?

This tutorial is all about progress in human-computer interfaces for making music from past NIMEs.
Objectives

1. introduce the theory and practice of NIME
2. NIME community is very accessible and growing
3. get to know some of the people of NIME
4. easy to start creating NIMEs and a lifetime of enjoyment to master
5. musical expression transcends gender and culture
6. if you are not having fun, it’s probably not for you
A Brief History of NIME

“New Interfaces for Musical Expression”
First organized as a workshop of ACM CHI’2001
Experience Music Project - Seattle, April, 2001
Lectures/Discussions/Demos/Performances
A Brief History of NIME

NIME-02 - Media Lab Europe, Dublin in May 2002
Conference-scale event with similar format to the
NIME-01 workshop
… held annually since 2001
NIME Themes

• Novel controllers & interfaces
• Performance & composition with new interfaces
• Interfaces for collaborative performance
• Real-time gestural control of music
• Interfaces for musical novices & education
• Cognition in Musical Interface Design
• Haptic & force feedback in musical control
• Artistic, cultural, and social impact
Tutorial structure

• Part I - 9:00 - 10:30
  – Module 1: So you want to build a NIME…
  – Module 2: Camera-based Interfaces
  – Module 3: Design & Aesthetics of NIME
  – Discussion (if time)

• Break 10:30 - 10:45

• Part II - 10:45 - 12:00
  – Module 4: NIME after NIME
  – Module 5: NIME Theory
  – Module 6: NIME Education
  – Discussion
Module 1: So, you want to build a NIME

Six step procedure
Sensors
Mapping
Synthesis
Demonstration
Six steps to build a NIME

1. Pick control space
2. Pick sound space
3. Pick mapping
4. Connect with software
5. Compose and practice
6. Repeat

1 and 2 often switched.

Tools to help with steps 1-4.
An example: Tooka *(Fels et al., 2004)*

Vibrato

Pitch Bend

mapping with PureData

Octave

Sustain

Pitch

Volume

sound synthesis

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Pick your control space

• Plethora of sensors available to measure:
  – motion of body parts
    • position, rotation, velocity and acceleration
  – translation and rotation (torque) forces
    • isometric and isotonic sensors
  – pressure
  – airflow

  – proximity
  – temperature
  – neurophysiological signals
    • heart rate
    • galvanic skin response
    • brain waves
    • muscle activities
  – light levels
  – and more…
Physical property sensors

- Piezoelectric Sensors
- Force Sensing Resistors
- Accelerometer (Analog Devices ADXL50)
- Biopotential Sensors
- Microphones
- Photodetectors
- CCDs and CMOS cameras
- Electric Field Sensors
- RFID
- Magnetic trackers (Polhemus, Ascension)
- and more…

What can I measure?
Human Action Oriented Sensors

• Here’s a few:
  – Bend - piezo-resistive
  – Close - IR reflection, 1-7”
  – FarReach - ultrasonic (50Hz update)
  – Flash - phototransistor
  – Gforce - piezo-electric single axis accelerometer
  – Hot - zener effect (thermocouple)
    • -40 to 100deg C
  – Light - photo-resistive

How do I measure that?
Human Action Oriented Sensors

- Reach - EMF disturbance
- Slide - resistive
- TapTile - Force sensitive resistor
- Tilt
  - electrolytic, single axis (-70-+70 deg)
- Touch - 0 travel FSR
- TouchGlove
  - several touch sensors
- TouchStrip
  - long touch sensor
- Turn
  - potentiometer
Connecting sensors

- Sensor response requires transduction and digitizing:
  - electrical
    - voltage
    - resistance
    - impedance
  - optical
    - colour
    - intensity
  - magnetic
    - induced current
    - field direction
  - mechanical force
Digitizing

- converting change in resistance into voltage
  - typical sensor has variable resistance ($R_{sensor}$)

$$V_{out} = \frac{V_{src} \cdot R}{(R_{sensor} + R)}$$

A simple voltage divider circuit
Digitizers for Connecting to Computer

- Some MIDI synthesizers, i.e., Yamaha mu100
- Arduino board
  - USB
  - Bluetooth module for wireless A/D
- ICubeX
  - A/D to MIDI
- Phidgets
  - A/D to USB
- DAQ boards
  - A/D to computer bus
Mapping Sensor to Music

• The relationship between the change in the sensor value to the sound output is called a *mapping*
• The mapping defines how much effort to learn and play your NIME
• Last step is to control your sound output:
  – communication protocol
  – sound synthesizer

This is the heart of the course and what NIME community is specialized in.
Sound output control: communications

- Musical Instrument Digital Interface (MIDI)
  - electronic instrument standard defined in 1982
  - specifies;
    - connectors, data rates, electrical properties, etc.
  - 1 message/msec (approx)
    - note on/off, velocity is typical packet
    - control messages to change instrument synthesis

- Open Sound Control (OSC) (Wright and Freed, 1997)
  - TCP/IP, internet protocol, typically UDP based
  - faster, low latency, variable packet types
  - computer to computer, computer to hardware

- Internal protocols, i.e. DAQ driver
Sound Synthesis Techniques

• Methods
  – sampled
  – FM synthesis
  – additive/subtractive
  – granular
  – waveguide/physical modeling
  – scan

Sound Synthesizers

- Hardware MIDI synthesizers
  - Yamaha, Roland, Korg, Casio, Moog, Kawai, Symbolic Sound Corporation, Nord modular, and others

- Software
  - STK (Cook)
  - PureData (Pd, Puckette)
  - JASS (van den Doel)
  - Max/MSP (cycling74.com)
  - Chuck (Wang and Cook, 2003)
  - Supercollider (McCartney, 1996)
  - and others
A few practical notes

• Portable:
  – Batteries can be used to make portable
  – Wireless protocols available for portable

• Write pieces for the instrument

• Aesthetics are important

• Plan your checklist for performance
  – too many things can go wrong with technology

• Plan your staging
  – can severely impact performance of sensors

• Plan for producing stable versions
  – hard to learn to play if NIME keeps changing

• Have Plan A, B and C (and probably D)

Module 3 has more details.
Summary

• Making a NIME is usually easier than playing it (well)

• Choose your:
  – movement type
  – sound space
  – sensing

• Put together your input, mapping and output

• Now you are ready to:
  – practice, practice, practice and perform…
  – aesthetic principles covered in module 3
Module 2: Camera-based Interfaces

- Imaginary Piano: visual input only
- Iamascope: visual input and output
- Facial gesture musical interfaces: when vision may be your best option
- Reactable: vision + (passive) touch, through alignment
- Kinect-based instruments
Camera-based Interfaces

F₁ : visual feedback in the form of aligned graphics
Imaginary Piano: No visual feedback

Leonello Tarabella, NIME-02

- Video camera with motion-sensitive zone
- No primary feedback
Visual Input Only: Imaginary Piano

Leonello Tarabella, NIME-02
Visual Input & Output

- Iamascope
- This gives a colourful kaleidoscopic feedback of part of the player. Gestures are used to trigger harmonious chord progressions and arpeggios.
- Quite good coordination between sound and graphics
Iamascope - video
Facial Gesture Musical Interface

Figure 2 Schematic of the facial action driven musical controller.

Lyons, NIME-01
Mouthesizer

- Colour & intensity thresholding
- Morphological transform & filtering
- Connected components + shape analysis

Lyons et al., NIME-03
Mouthesizer Video
Guitar Effects Controller

Mapping:

\[ \begin{align*}
H & \quad \text{Cutoff Frequency of Resonant Low Pass Filter} \\
W & \quad \text{Distortion}
\end{align*} \]

Lyons (2001)
Mouthesizer Video
Guitar Effects Controller
Sonification of Facial Actions (SoFA)

- Optical Flow triggers samples
- Samples mapped to facial zones
- Frame is recalibrated with face detection “Saccades”

Figure 2: Sample facial action with associated optic flow vector fields illustrated as white line segments.

Figure 3: Facial Zones used to trigger MIDI events.

Funk et al., NIME-05

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Sonification of Facial Actions (SoFA)
Reactable

- Video tracking of marked pucks on a table
- Projection of visual feedback

- Sergi Jordà et al., Universitat Pompeu Fabra
- first presented at NIME-03
Reactable

reactable

a musical instrument with a tangible user interface
Summary

• Large number of works have used visual input and output as a way to enhance new musical interfaces
• General principle is that vision offers a powerful way to capture gestural input
• Visual output using camera input can provide transparency
Module 3: Design & Aesthetics of

- Technological Expressionism
- NIME & the Music Process
- Challenge of Performance
- Mapping & the Audience: Transparency
- Visual Feedback
- Interaction Metaphor
- Perry’s principles
Technological Expressionism

• Shock of the New
• Human-machine relationship

• Techno-fetishism
• Experimentalism
Mari Kimura w/ Lemur Guitarbot
NIME Favors a Return to Process-oriented Music

• “…we are in a period of restoring fluidity to the musical transformative process – of making music more process-oriented again and less artifact-oriented.”

Gideon D’Arcangelo, NIME-04

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New Folk?

Oh Shenandoah played on iPhone ocarina
From: hrdrockgrrl
Views: 25,959
Comments: 59
Challenge of Performance

• Audience may not understand your NIME
• Expectations may be varied
• No musical tradition to fall back on
• A demo is not a performance

Hisashi Okamoto, NIME-04
The First Sailing with Limber-Row
Hisashi Okamoto - Limber Row
Transparency for Performer & Audience

- Complicated mapping $\rightarrow$ OO
- Simplify $\rightarrow$ OT
- Complex mapping $\rightarrow$ TO

$T = \text{transparent}$
$O = \text{opaque}$

How to achieve $\rightarrow$ TT?

(Gadd et al, 2003)
Visual Cues & Transparency

- Visual Appearance of Instrument
- Visualization of Interaction
- Visualization of Sound Output
Transparency & Interaction Metaphor

• SoundSculpting (Mulder and Fels, 1998)
  - two Cybergloves and Trackers
  - map metaphor of rubber sheet onto sound space
  - transparent for audience and performer
Transparency
Simple & Direct Interface

Particle
Kanta Horio, NIME-04

• Contact Mics
• Magnets
• Paper clips
Aesthetics of Failure

- Suspense highlights the technological challenge
- If there are never difficulties, glitches etc… then the limits are not being pushed

Technical difficulty delayed this performance, but improved the outcome

Urko Fujii - HairDNA, Sonic Skin, and Samsara, formula for orgasm between human and technology
Some Design Guidelines: Perry’s Principles

• Rules of thumb for the design of digital musical instruments
• Several of the principles are heavily subscribed

“Principles for Designing Computer Music Controllers” *P. Cook, NIME-01*

Revised:

“Principles for Controlling Computer Music Designers” *P. Cook, Keynote talk,*
Perry’s Principles

Human/Artistic Principles

P1: Programmability is a curse
P2: Smart instruments are often not smart
P3: Copying an instrument is dumb, leveraging expert technique is smart
P4: Some players have spare bandwidth, some do not
P5: Make a piece, not an instrument or controller
P6: Instant music, subtlety later
Perry’s Principles

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P1: Programmability is a curse
P2: “Smart” Instruments are Often Not

• “Easy to add complexity, features, bandwidth”
• But instruments can quickly become complex, unstable, and difficult to learn
• It is tempting to A.I. to instruments but this can often be bad design if the player feels the instrument too obviously has a ‘mind of its own’
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P5: Make a piece not a controller
P6: Instant Music, Subtlety later

- Making music is the goal
- The ideal new musical interfaces has:
  ‘Low entry fee with no ceiling on virtuosity’

\[ \text{Wessel \& Wright, NIME-01} \]

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**Figure 1.** Approximate learning curve for the (a) kazoo, (b) kalimba, (c) piano and (d) violin, within a period of 10 years.

\[ \text{Jorda, NIME-04} \]
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Perry’s Principles*

Technological:
P7: Miracle, Industry Designed, Inadequate
P8: Batteries, Die (a command not an observation)
P9: Wires are not that bad (compared to wireless)

Misc.:
P10: New algorithms suggest new controllers
P11: New controllers suggest new algorithms
P12: Existing Instruments suggest new controllers
P13: Everyday objects suggest amusing controllers
Perry’s Principles*

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P13: Everyday objects suggest controllers that are both amusing & good

- Sonic Banana (E. Singer, NIME-03)
- Java mug & Fillup Glass (P. Cook, NIME-01)
Eric Singer - Sonic Banana
Perry’s Principles*

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Perry’s Principles*

New (as of 2007)

P14: More can be better (but hard)
P15: Music + Engineering is a great Teaching (and Marketing) tool
P17: Younger students are more fearless
Perry’s Principles*

New (as of 2007)

P14: More can be better (but hard)
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P17: Younger students are more fearless
P15: Music + Engineering is a great Teaching Tool

- High student interest
- Motivation for learning a range of core topics including:
  - Sensors
  - HCI
  - DSP
  - Math skills
  - Programming
  - Networking

Joe Paradiso & student (NIME-02)
Summary

• Technology is increasing the fluidity of musical culture
• NIME presents special challenges for performers
• Well-designed visual feedback can greatly improve mapping transparency for audience and player
• Interaction metaphors another strategy
• Initial failure can enhance eventual success
• Perry’s principles provide practical policies
Questions/Discussion
Break
Module 4: NIME after NIME

Sensor(s) → Mapping → Sound
Original NIMEs

• Leon Theremin, 1928
  – senses hand position relative to antennae
  • controls frequency and amplitude
  – Clara Rockmore playing

Moog version

frequency

volume
More original NIMEs

- Hugh Le Caine (1940s)
  - electronic sackbut
  - sensor keyboard
    - downward and side-to-side
    - potentiometers
  - right hand can modulate loudness and pitch
  - left hand modulates waveform
    - precursor to the mod-wheel
Electronic Sackbut

1971 commercial version
Buchla’s Midi Controllers

• Thunder (1990)
  – 36 touch sensors

• Lightning 2 (1996)
  – LED based position sensing

• Marimba Lumina (1999)
  – pads and ribbon controllers (strips)
  – bars are sensitive to proximity, hit location and movement
  – 4 different mallets for different effects
Buchla 200e Series music controllers

- Modules can be combined:
  - Control and Signal Router
  - Multi Dimensional Kinesthetic Input Port
  - Midi Decoder/Preset Manager
  - System Interface Arbitrary Function Generator (2 panel units)
  - Complex Waveform Generator
  - Source of Uncertainty
  - Quad Function Generator
  - Frequency Shifter / Balanced Modulator
  - Triple Morphing Filter
  - Quad Dynamics Manager
There’s a lot of NIMEs out there

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
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<td>36</td>
<td>31</td>
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</table>

Table 3.2: Classes of instruments presented at the NIME conferences, by year (Marshall, 2009)

- Most are classed in the “Alternate” category
- NIME2011 continues this trend
  - propose new Alternate sub-category: touch surface
Augmented Instruments

• **Hypercello** *(Gershenfeld & Chung, 1991)*

  - related Hyperbow *(Young, 2001)*

---

**Yo-Yo Ma, Tanglewood on August 14, 1991**
Augmented Instruments

• Yamaha Disklavier
  – MIDI controlled acoustic piano
  – solenoid actuators to play keys
  – records key press

• Radio Baton + Disklavier performance
Augmented Instruments

• Hyper-Flute *(Palacio-Quintin, 2003)*
  – standard Boehm flute
  – sensors:
    • magnetic field, G# and C# keys
    • ultrasound tracking
    • mercury tilt switch
    • pressure sensors (left hand and thumbs)
    • light sensor
    • buttons
Alternative Instruments: Using different sensors

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<thead>
<tr>
<th>Sensor</th>
<th>Occurences</th>
<th>Property Sensed</th>
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<td>FSR</td>
<td>68</td>
<td>Force</td>
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<td>Accelerometer</td>
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<td>Acceleration</td>
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<td>Video Camera</td>
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<tr>
<td>Button/Switch</td>
<td>51</td>
<td>Position (On/Off)</td>
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<td>Rotary Potentiometer</td>
<td>31</td>
<td>Rotary Position</td>
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<td>Microphone</td>
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<td>Sound Pressure</td>
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<td>Linear Potentiometer</td>
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<td>Linear Position</td>
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<tr>
<td>Infrared Distance Sensor</td>
<td>27</td>
<td>Linear Position</td>
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<td>Linear Position Sensor</td>
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<td>Linear Position</td>
</tr>
<tr>
<td>Bend Sensor</td>
<td>21</td>
<td>Rotary Position (Bending)</td>
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</tbody>
</table>

Table 3.3: Most popular sensors from NIME instruments

*(Marshall, 2009)*
Alternative Instruments

• how to organize:
  – sensed property (i.e. wind)
  – player action (i.e. percussion)
  – instrument shape
  – relationship to body
Hands Only - free gesture + physical

• Lady’s Glove (*Sonami, 1991+*)
  – hall effect sensors, microswitches, resistive strips, pressure pad, accelerometer
  – controlled musical effects
free gesture + contact gesture + voice

- The Hands (Waisvisz, 1984)
Hands Only - free gesture

- Manual Input Sessions
  (Levin and Leibermann, 2004)
  - camera and OHP

- SoundSculpting (Mulder and Fels, 1998)
- GloveTalkII/GRASSP/DIVA, (Fels et al., 1994+)
  - cybergloves, tracker, switches
  - controlled formant synthesizer
- and more…
Hands - Contact gesture

- Most typical type of NIME
- Ski (*Huott, 2002*)
  - fibre optic multitouch pad
    - Tactex Inc.
  - mappings:
    - playback: linear, polar and angular control modes
    - percussive
    - pitch tuning:
      - MIDI controller
      - upright form factor
Hand - Contact gesture

• Pebblebox (O’Modhrain & Essl, 2004)
  – microphone + stones
  – granular synthesis

• play with stones
  – mixes granules
Hand - Contact gesture

- Crackle box (*Waisvisz, 1975*)
  - analog circuit
  - op-amp with body resistance connected to pins
  - in the tradition of circuit bending
Hand - Contact gesture

- Lippold Haken’s Continuum
  - touch sensitive - neoprene covered
    - x, y along board
    - z - pressure
  - MIDI controller
    - sound effects
    - continuous frequency
    - pitch bends

Jordan Rudess (Dream Theater), 2005
Breath and Hands

• iPhone Ocarina (*Wang*, 2009)
  – touch screen plus microphone
  – mapped to tones for ocarina sounds
Face/Head Control

- **eSitar** *(Kapur et al, 2004)*
  - accelerometer for head tilt
  - experimented with volume, duration, and more
- **Mouthesizer** *(Lyons et al., 2003)*
- **SoFA**, *(Funk et al., 2005)*
- **Tongue’n Groove** *(Vogt et al., 2002)*
  - ultrasound probe to measure tongue movement
Body

- **Miburi from Yamaha, 1994**
  - bend sensors at arm joints
  - two buttons/finger and thumb
  - two pressure sensors/foot
  - MIDI controller
Inside Body

- **Biomuse** *(Knapp and Lusted, 1990)*
  - 8 channel signal amp
    - EMG, EKG, EOG, EEG

- **Tibetan singing bowls** *(Tanaka and Knapp, 2002)*
  - EMG and position sensing

- **miniBioMuseIII** *(Nagashima, 2003)*
  - 8 EMG channels
    - mapped to bandpass filters, sinewave generators and FM synthesizers
  - used in BioCosmicStorm-II
Collaborative Instruments

• **Tooka** *(Fels and Vogt, 2002)*
  – pressure for breath
  – buttons for fingers
  – bend sensor
  – touch sensor

• two players share breath
• coordinate movements
• MIDI mapping
Collaborative Instruments

• **OROBORO** *(Carlile & Hartmann, 2005)*
  - haptic mirror between hand paddles
  - 4 FSRs/hand
  - mapped using Pd to:
    • violins sounds
    • sampled sounds
Nime for Novices: Jam-o-drum *(Blaine and Perkis, 2000)*

- 4 player audio/visual interface
  - drum pads sensors with rotation sensor around rim
- Drum circle concept
- Various musical games
  - turn taking
  - collaboration
Jam-o-drum (Blaine and Perkis, 2000)
NIMEs for Novices

• Interactive instruments embody all of the nuance, power, and potential of deterministic instruments, but the way they function allows for anyone, from the most skilled and musically talented performers to the most unskilled members of the large public, to participate in a musical process (Chadabe, 2002)

• Walk up and play
### NIMEs for Novices

*(Blaine & Fels, 2003)*

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Single player</th>
<th>Multiple players</th>
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<tbody>
<tr>
<td></td>
<td>Single interface</td>
<td>Multiple interfaces</td>
</tr>
<tr>
<td>Aptitude</td>
<td>Novice</td>
<td>Virtuoso</td>
</tr>
<tr>
<td>Single player</td>
<td>Electronic Bullroarer Iamascope</td>
<td>Jazz Ensembles</td>
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<tr>
<td>Multiple players</td>
<td>Musical Trinkets</td>
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<tr>
<td>Single interface</td>
<td>Beatbugs Squeezables Audio Grove Sound Mapping Speaking Orbs Jamodrum</td>
<td>Mikrophonie I, Tooaka</td>
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<tr>
<td>Multiple interfaces</td>
<td>Augmented Groove Brain Opera Drum Circle</td>
<td>Mikrophonie II</td>
</tr>
</tbody>
</table>

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Brain Opera  
(Machover et al, 1996)

- Multiple NIMEs as part of a larger connected set of interaction
  - Forest station
  - Harmonic driving
  - Melody easel
  - Rhythm tree
  - Gesture wall
  - Digital baton
  - Audience sensing in performance space
  - Sensor chair
Brain Opera  *(Paradiso, 1999)*

- **Sensor chair**
  - multiple antenae to track hand positions
  - two antenae for feet
  - buttons
  - lights

- **MIDI mapping**
Brain Opera NIME
Summary

• Creating a NIME is easy to do
• Creating a good mapping is hard
• Playing it well takes practice to be a virtuoso
  – some NIMEs created to be easy to play but not so expressive
• Without a piece, difficult to gain acceptance
• Often audience doesn’t know what is going on
• Many explorations trying different ways to make music
Module 5: NIME Theory

- Generic model of a musical interface
- Role of feedback from the interface
- Mapping problem
NIME – Generic Model

M : Mapping,
F₁, F₂ : Primary & Secondary Feedback

Based on: Miranda & Wanderley (2006)
‘Traditional’ Instrument

Gestural Input

Controller \( \rightarrow \) Sound

\( F_1 \rightarrow \) Primary Feedback

\( F_2 \rightarrow \) Secondary Feedback

\( M \) : Mapping,

\( F_1, F_2 \) : Primary & Secondary Feedback

I : Interface

Based on: Miranda & Wanderley (2006)
NIMEs decouple

- Control separate from Synthesis
- Mapping (M) is designed
- Feedback (F1 and F2) is designed
- Controller/Interface is designed
NIME representations

• discrete vs. continuous controllers
  – keys vs knobs
• acoustic vs electronic sound output
  – vibrating string vs. speaker
• digital vs analog representations
  – bits vs. voltage
NIME, DMI, Instrument

• musical interface and nime used interchangeably
• DMI – ‘Digital Musical Instrument’
• DMI & MI may be preferable because a NIME will not be new forever
Digital NIME

- Computer enables arbitrary design of interface behaviour:
  - controller
  - feedback (F1 & F2)
  - mapping (M)
  - synthesizer
NIME – Generic Model

Gestural Input

M : Mapping,
F₁, F₂ : Primary & Secondary Feedback

Based on: Miranda & Wanderley (2006)
Designing Controllers: Gestural Input

• Free gesture interfaces
  – no physical contact
• Physical contact interfaces
  – all acoustic instruments
• NIMEs can be in either
Free Gesture Interface

• Theremin (1919)
• Sound feedback (F₂) only
• No primary tactile
  or visual feedback (F₁)

• Have been few virtuosos
• Considered difficult to
  master

Léon Theremin
Theremin lacks significant primary feedback
The Hands

Michel Waisvisz et al.
STEIM, Amsterdam
(Studio for Electro-instrumental Music)

• Passive $F_1$
NIME – Generic Model

Gestural Input

Controller

Sound Synthesis

M : Mapping,

F₁, F₂ : Primary & Secondary Feedback

Based on: Miranda & Wanderley (2006)
Feedback Design: F1 and F2

- Sound
- Tactile*
- Kinesthetic
- Visual**

*Includes vibro-tactile feedback due to sound waves on the instrument

** Re: Module 2 on Visual Interfaces
$F_1: \text{Visual \& Tactile Feedback}$

*The digital music instrument for the 21st century*

*Nishiburi \& Iwai NIME-06*
Tenori-on
NIME – Generic Model

Gestural Input

Controller

M: Mapping,

F₁, F₂: Primary & Secondary Feedback

Based on: Miranda & Wanderley (2006)
Instrument Mapping

Shakuhachi

Fairlight CMI, 1980s Polyphonic Digital Sampling Synth

T. Kriese

Matrix (Overholt, 2001)
‘Mapping Problem’: How to design the gesture to sound mapping?
Aspects of the Mapping Problem

- Dimensionality
- Complexity
- Mapping Strategy
- Other aspects …

The mapping layer can be considered as the essence of a musical interface

*Hunt, Wanderley, and Paradis (2003)*
Dimensionality: Types of Mapping

1-to-1

1-to-N

N-to-1

N-to-N

Gestural Parameters

Synthesis Parameters
Complexity:
Simple & Complex Mappings

Simple

Complex

Mapping Complexity

complexity can lead to better expression
- 1 to 1 usually doesn’t do the trick
  * not interesting
  * not enjoyable
  * not satisfying

Hunt, Wanderley, & Paradis, NIME-02
Understanding Complexity: Three Layer Mapping Strategy

Hunt, Kirk, and Neighbour (2004)
Abstract Mapping Layer example

Mouthesizer interface (Module 2: Camera-based Interfaces)
Controlling a Formant Filter using Mouth Shape

Lyons et al., NIME-03
Mouthesizer Vowel Mapping
Mapping Design Strategy

• Advantage to have a control interface which is based on the **perceptual qualities** of timbre spaces

• Better mapping leads to more playable interface

• How do we characterize playability?
Musical Control Intimacy

“... the match between the variety of musically desirable sounds produced and the psycho-physiological capabilities of a practiced performer.”

Moore (1988)

Control Intimacy depends (somehow) upon gesture to sound mapping
Flow in musical expression

- Special contact with the instrument
- Development of a subtle feeling for sound
- Feeling of effortlessness
- Playful & Free-spirited feeling handling of the material
  - *A. Burzick (2002)*
Threats to Intimacy

- Latency between gesture and sound
- Lack of primary feedback
- Poor mapping
Summary

- Generic musical interface model is helpful in understanding what makes & breaks a NIME
- Mapping constitutes the essence of a digital NIME
- Mapping is not straightforward and many design ‘strategies’ have been tried
- Multiplayer mappings can be better than simple one-to-one mappings
- Studies of mapping and feedback are core research topics of NIME
Module 6: NIME Education
Education and NIME

- Sound Synthesis
- Sensors, Effectors, Microcontrollers
- Basic Electronics
- Communication Protocols (MIDI, OSC, TCP etc.)
- Sound Synthesis and Processing
- Acoustics
- Human-Computer Interaction
- Music
Where to study this field?

- IRCAM, Paris
- CCRMA, Stanford
- CIRMMT, McGill
- Princeton, CS & Music
- NYU Interactive Telecommunications Program
- SARC, Queen’s, Belfast
- Growing field …
- URLs listed in the References
Specific Learning Resources

- Miranda & Wanderley (2006)
- Igoe (2007)
- Roads (1996)
- NIME Proceedings
- ICMC Proceedings
- Computer Music Journal
- Organized Sound
- J. New Music Research
Curricula

• beginning graduate or senior undergraduate level
• Courses tend to be project oriented
• Students learn what they need
• Live performance or Demo is necessary for completion of the course (ITP, CCRMA)

Verplank, Sapp, Matthews (NIME-01)
• NYU ITP NIME Course
• Master’s program in design & technology attracting students from a wide range of backgrounds

Gideon D’Arcangelo
Hans C. Steiner
Jamie Allen

Taku Lippit (NIME-04)
NIME Curriculum - Topics

• Historical Survey of Musical Instrument Types
• Attributes of Musical Expression
• Music Theory and Composition
• Musical Interface Responsiveness
• Discrete vs. Continuous Controllers
• Gestures and Mapping
• Novice and Expert Interfaces
• Spectacle and Visual Feedback in Performance
• Collaborative Interfaces
Summary

- Substantial resources for learning about NIME
- NIME courses are usually project based
- Number of universities offering programs of study is expanding
- Next frontier: high schools, science fairs
Concluding Remarks
How to Play the Computer?

• Computers offer a wide range of sound and music creation opportunities
• How can we create new interfaces to play computers in a way that is appropriate to human brains & bodies?
Here’s how…

• NIME tools
• NIME principles
• NIME examples
• NIME theory
• NIME education
How to get involved

• NIME community
  – community@nime.org
    • subscribe with community-request@nime.org

• NIME website
  – www.nime.org

• ICMC website
  – www.icmc2009.org

• Other computer music conferences
Bigger picture

1. introduced the theory and practice of NIME
2. NIME community is very accessible and growing
3. get to know some of the people of NIME
4. easy to start creating NIMEs and a lifetime of enjoyment to master
5. musical expression transcends gender and culture
6. if you are not having fun, it’s probably not for you
Questions & Discussions

• Contact us:
  – Sidney Fels, ssfels@ece.ubc.ca
  – Michael Lyons, lyons@im.ritsumei.ac.jp

www.nime.org