Wearable Instruments

Wearable Sound

Sha XinWei
Responsive Spaces

IN THE WILD • 2001
Thick in-vivo Experiments

In a continuous, responsive, dense, living space –

How do we coordinate action without explicit language?
How do we improvise gestures?
What makes something palpable?
How we become more adept playing? Virtuosity.
Staging
Two Phenomena

Induced tangibility

A-linguistic learning & articulation
Induced tangibility

(play hopskip) Ars Electronica 2001
Discovery & Improvisation
Responsive Media Spaces

IN THE LAB • 2001-2003
Blair MacIntyre
Erik Conrad
Junko Tsumuji
James Hsu
Yon Visell
Kat Tejavanija
Jehan Moghazy
David Demumbrum
Jim Ransone
Yoichiro Serita
Yvonne Caravia
Sunderesan Jayaraman
Sungmee Park
Wolfgang Reitberger
Vinny Fiano ...

Topological Media Lab

School of Literature, Communication and Culture
New Media Center
Graphics and Visualization Lab
Georgia Institute of Technology
Topological Media Lab
Gesture & Materiality

Hybrid computational / physical material

- Tangibility and materiality
- Temporal textures
- Gesture
- Domestic spaces
  - Design and inhabit rich, responsive, dense media
- Urban spaces
Wearable Computing

Body-borne and Environmental Sensors

Wireless

TinyOS, motes (UC Berkeley, Intel; Dey, Paulos)

Active Fabrics, Softwear

Softwear collaborations (Jayaraman, Park; Tejavanija; Berzowska)
Applied Pattern/Signal Analysis

Vision tracking
Gesture tracking
Speech tracking
Media Choreography

Realtime video and sound synthesis
Responsive Media Authoring Systems
Continuous Time State-Evolution
Media Choreography

Substrate “physics” (proto-narrative)
Architecture

IPAQ/Linux & Accelerometers

Sensor Data

Player Position Tracking

Sensor Data

Interactive Visualization & Control

Metaphorical Data

OSC

Sensor Data

Metaphorical Data

Sensor Data

Media Choreography

Sensor Statistics

MAX

Nato/Jitter

Video Projection

SuperCollider

Speakers
Statistics
“Intention” and “Learning”

Preliminaries

Calibration (accelerometers and IR)
Data throttling

Scalar vs 1d or 2d array

Instantaneous or integral
Integration over time or sample

Application: Leaky accumulator for slewing
Dynamical System on Simplicial Complex

Statistical Physics

States Manifold: meaningful experience, as metaphors
State: (convex) combination of pure states
Potential energy $U = E(\text{sensor}) + E(\text{static})$
Kinetics: $F = -\text{Grad}[U]$

Arnold, Classical Mechanics
Itzykson & Drouffe, Statistical Field Theory
Jordan, Learning in Graphical Models
Phase Space Topology: Room

cantus firmus
Phase Space Topology: Player
Dynamical System Overview

Total manifold = Metaphorical State x Observables

\[ M = \prod_{p=0}^{N_p} M_p = \prod_{p=0}^{N_p} \Gamma_p \times S_p. \]

\[ \gamma_p(t) = \sum_{j=1}^{N} \lambda_j(t) v_j \]

\[ \sum_{j=1}^{N} \lambda_j(t) \equiv 1. \]
Energetic Model

\[
U[\gamma_p(t)] = \sum_{\nu_i \in \sigma(\gamma_p(t))} f(\lambda_i) \left\{ e^{-\beta E_k[s_{\alpha,p}(t)]} + g_s \phi_k + g_V V_k \right\}
\]

\[
E_k[s_{\alpha,p}(t)] = \sum_{\alpha \beta = 1}^{N_s} \frac{(\mu_{\alpha k} - s_{\alpha,p}(t))(\mu_{k \beta} - s_{\beta,p}(t))}{\sigma_{\alpha \beta}}
\]
Dynamics

\[ F[\gamma_p(t)] = -\nabla U - \xi \dot{\gamma}_p(t) \]

In convex coordinates

\[ F_k = \frac{-dU}{d\lambda_k} - \xi \dot{\lambda}_k \]

Discrete states and discrete transitions are special case
Good framework to handle noise, hysteresis.
Equation of Motion

∇U on phase space

The evolution is given by

\[ \dot{x}_m \rightarrow \dot{x}_m + \frac{1}{m} F^t_m \, dt \]

\[ x_m \rightarrow x_m + \dot{x}_m \, dt \]

where

\[ dt = \text{integration timestep} \]
\[ m = \text{mass of particle} \]
Resonance Response  May 2002

Spectral Methods (Kac)
Wearable Instruments: Wearable Sound

Phenomenological Experiments

Experimental Phenomenology
Softwear: Body + Garment

Matter, Poetry and Poiesis

Patterns: tattoos, (virus), resonance

Gesture instrument

Material as memory, amplification

Thick space
Fabric Media

S. Jayaraman and S. Park @ Georgia Tech
J. Berzowska; E. Kusaite, M. Kuzmanovic et al.; S. Diamond et al.
K. Tejavanija, Y. Caravia, J. Fantauzza @ TML
Research Agenda

Experimental
- Gesture, Movement
- Tracking, Feature Extraction
- Continuous Media Choreography
- Softwear, Wireless Sensors, Fabric

Design
- Realtime Video Synthesis
- Realtime Sound Synthesis

Applications
- Softwear: wearable sound
- Responsive Media Spaces