

A scientific approach to gesture ~~recognition~~ tracking in performative environments

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motivating examples
Responsive Environments



How can we build a world that's not complicated, but rich?

Smart environments?? airports,
streets, EV

Strategy: look to experience from live
performance and architecture

TGarden responsive playspaces

(1997) 2001-2002

Stanford; FoAM, Starlab Brussels; Banff New Media
Institute; Georgia Tech.

Exhibited: Siggraph 2000, Medi@Terra Athens 2001,
Ars Electronica Linz 2001, DEAF Rotterdam 2001;
subsequent: txOom & tgvu 2002

Preliminary TGarden 2000



SXW, Sponge, FoAM collectives, SIGGRAPH New Orleans

events in responsive spaces (chamber scale)



SXW TGardens 2000-2001 sponge +

events in responsive spaces (building scale)



conditions

Live, embodied experience

Real-time, performative events

Collective as well as individual

Improvised (no a priori)

What's a gesture?

Human movement

Vocal (vs sonic) movement

Elicits response

SXW, "Resistance Is Fertile: Gesture and Agency in the Field of Responsive Media," *Configurations*, Vol 10, Number 3, Summer 2002.

What does real-time imply?

End-to-end latency: from *onset* (mouse-down, not mouse-up) of gesture to perception of media response

Table 1 Human interaction bounds

Type of feedback	Frequency Hz	Latency ms
visual	15-25	50
acoustic	5-10	10-50
acoustic (melodic)	50	10
haptic	1000	1

latency \neq rhythm

What sense modality?

machine sense \neq human sense

sensor modality \neq sense modality

Regimes of sensing

regimes of sensing vs. sensor modality
scales of distance x energy (example):

>> 1m x multiple bodies (pedestrian flow)

~ 1m x limb extension (greeting)

0 x contact (handshake)

touch nuance (caress,

Jill Fantauzza, et al., "Greeting Dynamics Using Expressive Software" (UbiComp 2003)

what sensor modality?

Physical or physiological?
Critique of psychologism

Descombes, V. (2001). The Mind's Provisions: A Critique of Cognitivism, Princeton University Press.

Martin Kusch, Psychologism, Stanford Encyclopedia of Philosophy, 21 Mar 2007

intrinsic vs extrinsic

Saussure: any semiotic system is an abstract system of differences

Bobick: Kid's Room method

continuous vs discrete

what can we do without tokenizing?

work with streams

(discretized) continuous model \neq discrete model

what is noise?

“heat” noise in the sensor

network or operating system indeterminacies

non-semantic signal

push vs. poll

Better sense of coupling, causality for gesturer.

You can feel when the system stops responding.

Joel Ryan, Institute of Sonology, and STEIM

some projects

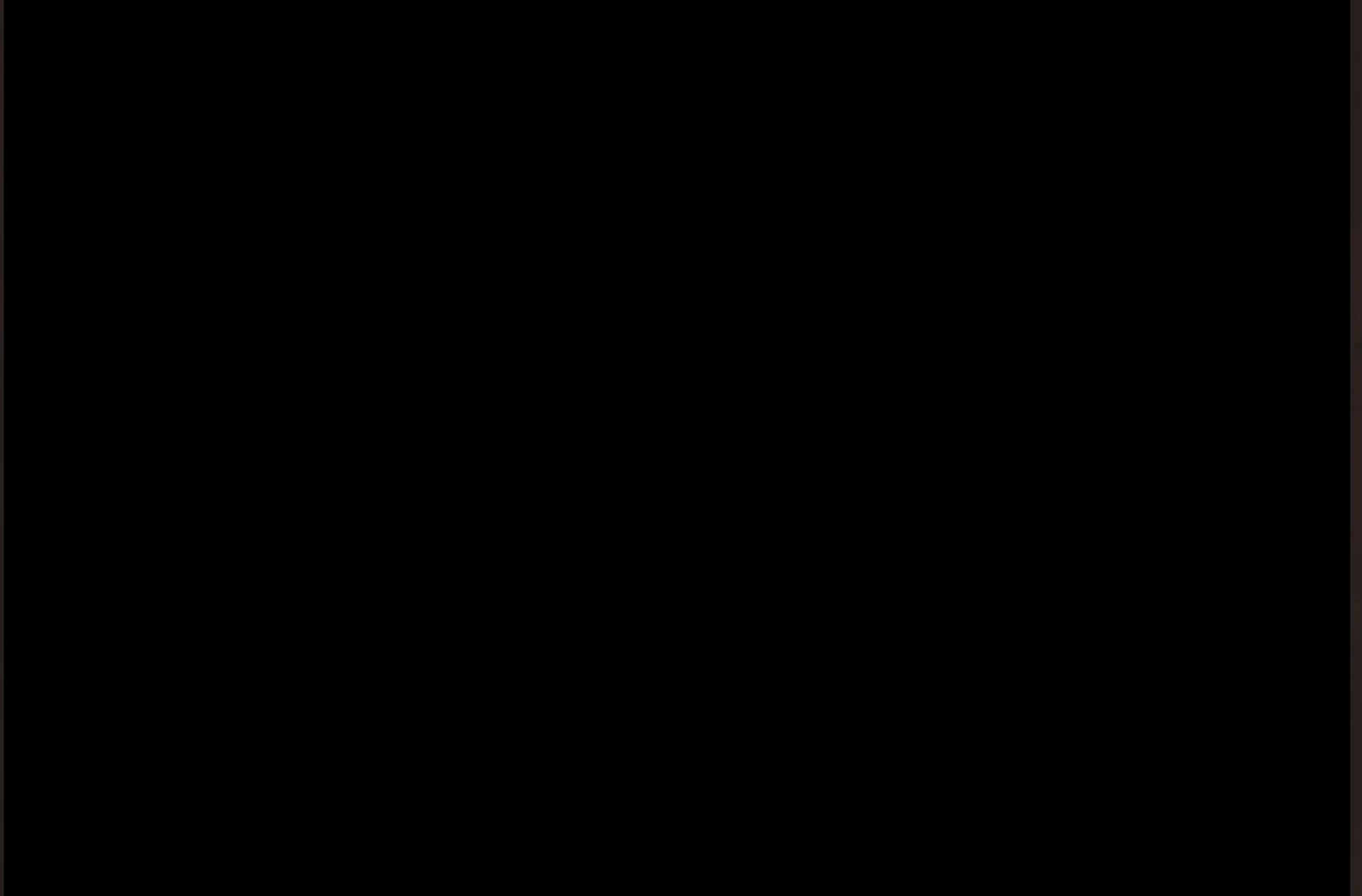
Continuous Sensing of Gesture for
Control of Audio-Visual Media

Xin Wei Sha, Giovanni Iachello,
Steven Dow, Yoichiro Serita,
Tazama St. Julien, Julien Fistre

continuous gesture tracking for sound

*SXW, et al, Continuous Sensing of Gesture for Control of Audio-Visual Media
(ISWC 2003)*

angular moments to continuous sound



SXW, Yvonne Caravia, Yoichiro Serita, Georgia Tech IDT

Platform (Iachello, Dow, Serita)
Usage (Sha, Serita, Ubicomp)

*SXW, et al, Continuous Sensing of Gesture for Control of Audio-Visual Media
(ISWC 2003)*

controlling what?

sound file play back vs continuous synthesis

not triggers, sound \neq {objects in space}

classical methods for sound synthesis:

vocal formants (howling ball txOom)

granular synthesis

motes, MSP instruments



SXW, J Fantauzza, Ubicomp

WYSIWYG

Wearable Sound Gestural Instruments

SXW - Marcelo Wanderley

Hexagram

WYSIWYG

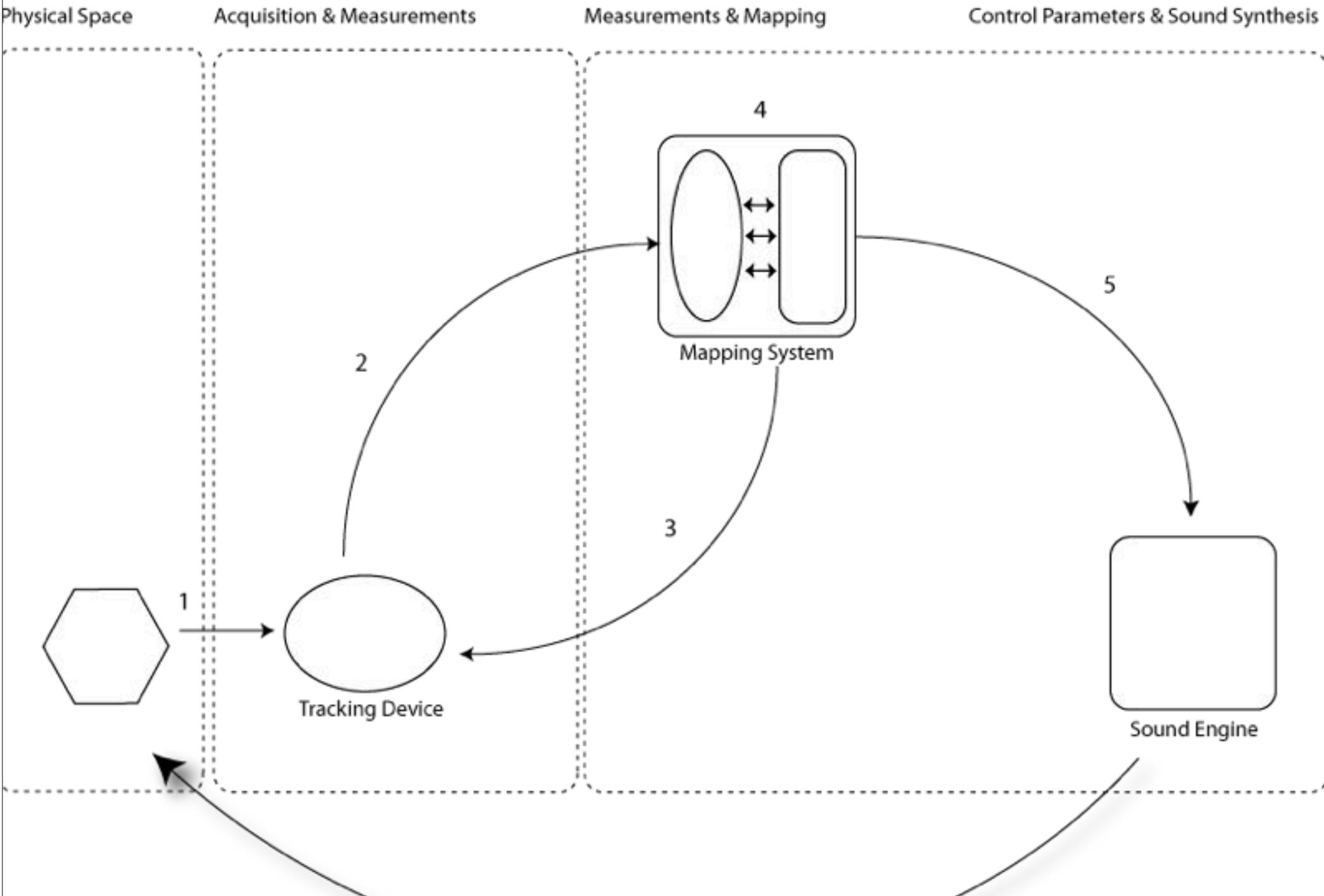
1 material, 2 general mapping, 3 time

- Soft, continuous₁ controllers
handkerchief, scarf, blanket
- Continuous₂ mapping to continuous₃ sound
- Improvised play
- *Collective* movement
- Technical Goal: Statistical correlates to *intentional* gesture

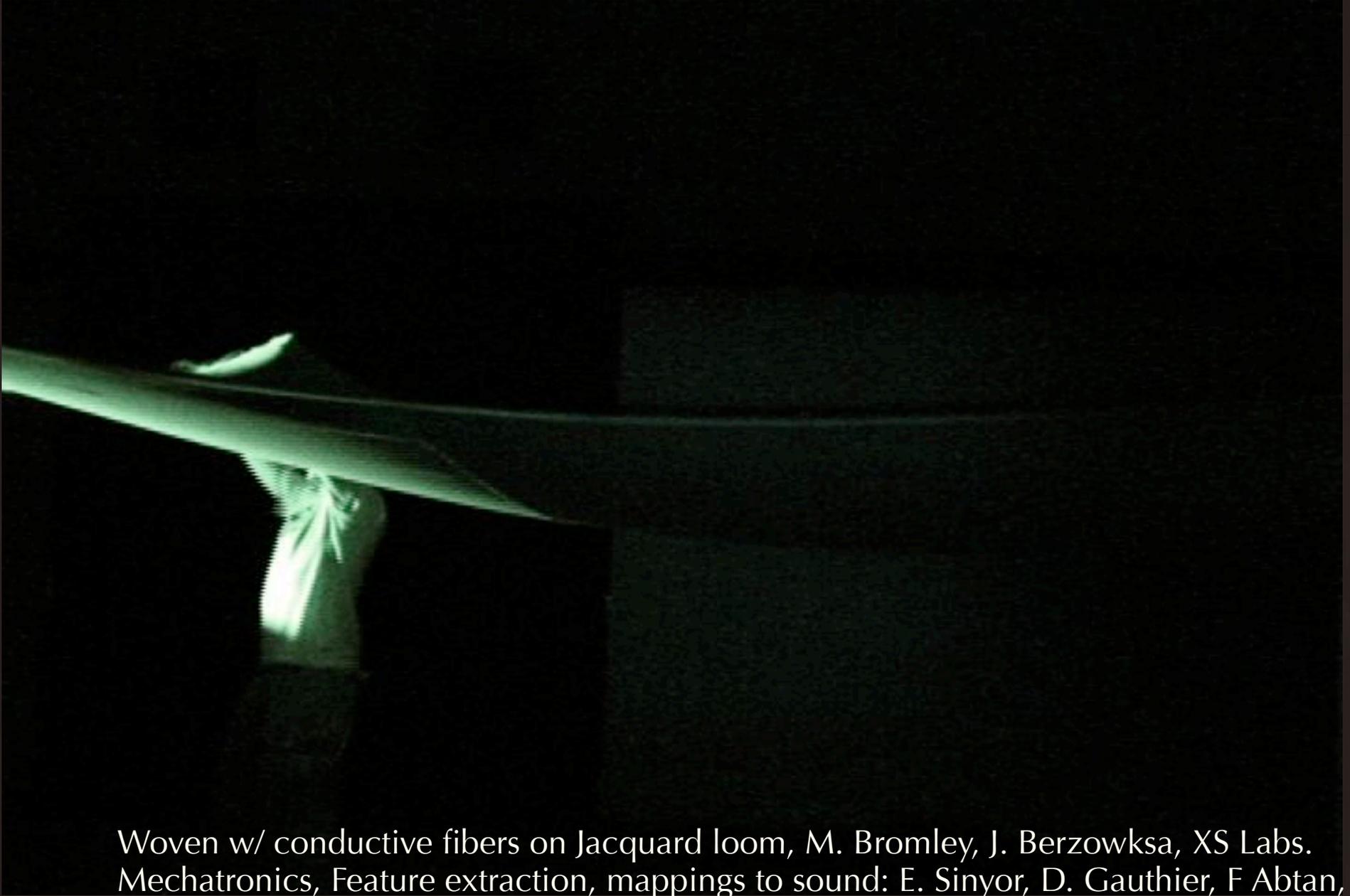
* Doug Van Nort, * David Gauthier, Sha Xin Wei, Marcelo M. Wanderley, "Extraction of Gestural Meaning from a Fabric-Based Instrument," *ICMC International Computer Music Conference Proceedings, 2007.*

* David Birnbaum, * Freida Abtan, Sha Xin Wei, Marcelo M. Wanderley, "Mapping and Dimensionality of a Cloth-based Sound Instrument," *Proceedings of Sound and Music Computing (SMC), Lefkada Greece, 2007.*

WYSIWYG architecture



WYSIWYG blanket test



Woven w/ conductive fibers on Jacquard loom, M. Bromley, J. Berzowska, XS Labs.
Mechatronics, Feature extraction, mappings to sound: E. Sinyor, D. Gauthier, F Abtan,
D. Birnbaum, D. v Nort
Choreography by SY Cho and members of Dance Department.

higher order features

Phase relationship between spatial locations

Periodicity as function of position

Harmonicity, generalizing “regular motion”

Directionality, as cue to focus and intent

But: we always start and end with human interpretant

Ouija

Collective gesture

Intentional gesture

Movement art: ***Improvisation** vs. choreography

* => *no a priori classifiers. But also, no grammar!*

Ostensive Experiments

Entrainment

pass dynamics body to body w/o explicit instruction
(un)rehearsed or (un)trained, 3-6 people

Contact Improv

Camouflage

Calligraphy

Delay

Implicit Experiments

Effects of no | passive | responsive temporal media on movement.

Future:

- Look (inspection) for emergence of co-articulation.

- Look for statistical correlates among sensor features.

Ouija: entrainment

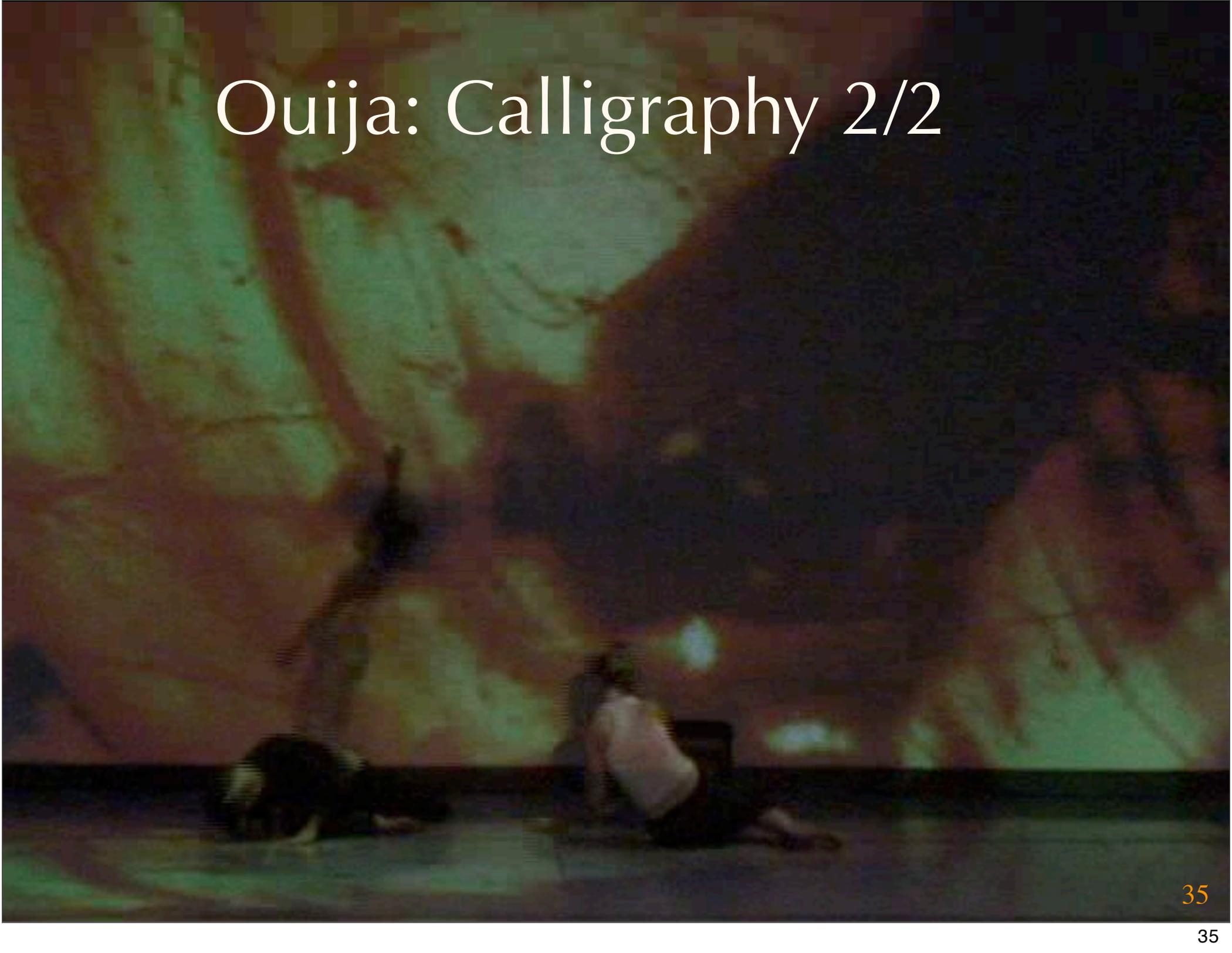


Ouija Experiment on Collective Gesture in
Responsive Media Spaces, June-July 2007

Ouija: Calligraphy 1/2

machine vision for feature extraction from movement,
continuous synthesis of video based on physics models,
leveraging corporeal intuition.

Ouija: Calligraphy 2/2



Ouija: Delay



Conventional performance's fixed sequence of movement =>
less need for realtime gesture tracking? *But how fixed is fixed?*

future work

expert movement analysis

Dr. S. Gill, Middlesex & Cambridge (Ian Cross)

non-verbal movement, rhythm and musicality in
movement

SXW, S. Gill, Gesture and Response in Field-Based Performance, Creativity and Cognition Conference, 2005.

expert movement analysis

D. van Nort, McGill (Marcelo Wanderley
IDMIL)

predictive and geometric models for gestural sound
e.g. correlation, ICA, realtime wavelets

D. Gauthier, M. Fortin

statistical correlates, not ~~certificates~~, of intention

Correlation, e.g. $R_n[k, i, j] = E(x_i[n]x_j[n - k])$, or

Kalman filter estimates of state $X(t)$ from
observables $y(t)$, of form

$$X(t + 1) = A(t)X(t) + b(t) + w(t)$$

$A(t)$ is the known square transition matrix of the process.

control $b(t)$ is given zero mean process noise $w(t)$

measured vector $y(t) = H(t)X(t) + v(t)$

$H(t)$ is the rectangular measurement matrix.

$v(t)$ is the zero mean measurement noise

minimizing covariance $P(t) = E[|X(t) - \bar{X}|^2]$

engineering note

Body gesture	Object “gesture”	Mechanical energy	Sensing technology	Price, Efficiency, Availability ¹
Any movement Any part [?] Sensitivity	Handling	Acceleration	Accelerometer	254
	Wearing		Piezoresistive	225
Hands Feet Lying/sitting	Throwing	Force Pressure	Air pressure	244
	Handling		Flexion	244
	Holding		Piezoresistive	234
	Pushing		Load cell	255
	Pressing		Miniature pressure transducer	154
	Squeezing		Piezoelectric	244
	Strain gauge		254	
Specific (cutting, etc.)	Strain Contact Presence	Capacitive	545	
Mouth Sweep Movements	Inside/outside	Humidity	Hygrometer	333
	Hydrophile material	Temperature	Piezoresistive	525
	Inside/outside		Piezoresistive	525
Energy/heat	Thermosensitive materials			
Hands Feet	Long objects	Linear position	Piezoelectric	242
	Large surfaces	2D Localization	Piezoresistive	545
			Capacitive	545
Articulation	Soft materials	Flexion	Piezoresistive	545
	Surface (de Rossi)			333
[?]	Rigid materials	Strain	Piezoresistive	545
Space movements		3D Localization	Video	
Body parts		Orientation	Tilting, acceleration, magnetic	244
		Rotation	Magnetic, piezoresistive	445
Contact/non-contact	Activation	Switching	Capacitive	545
			Piezo	545

- ¹ 1: Very poor
2: Poor
3: Moderate
4: Good
5: Very good

thanks to E. Sinyor

summary

Conditions:

Live, real-time, performative events

Collective as well as individual

Improvised (no a priori)

Strategy:

Leverage corporeal intuition

Continuous models

controllers, media, and mappings

geometrical / topological models

Statistical approaches

correlation

Kalman estimate state

topological media lab

Credits:

<http://www.topologicalmedialab.net>

→ People

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