The Sound and Touch of Ether's Flux

An interactive technology, philosophy, and creative work

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Abstract— The Sound and Touch of Ether's Flux **is both a creative work and a fluid artistic technology. It is the creation of unconventionally expressive music through spontaneous motions of the whole human body.**

Keywords- **music, interactivity, dance, choreagraphy, improvisation, iphone, wearables, kinect, algorithmic music, emergent properties, sensors, rtcmix, texture**

In our work *The Sound and Touch of Ether's Flux* we exploit new kinds of interactivity to address the relation of complexity to perception. Other interactive music technologies either generate individual sounds directly in response to discrete gestures or use gestures to manipulate playback of sampled sounds. [6, 23, 24, 28] Our approach differs fundamentally. The technology we've created allows the user-improviser to steer the flow of spontaneously generated algorithmic music that is partly stochastic. The motion-based interactivity manipulates macro or *emergent* properties through continuous input from analog sensors. Continuous quantities from the analog sensors feed into the music generating algorithms to serve as statistic bounds and seeds that correlate indirectly put palpably with *emergent* qualities whose flux can be heard.

The result is an algorithmically generated non-repeating stream of music that is expressive in that it enables mood shifts by allowing nuanced but audible emergent qualities to be spontaneously steered through continuous motions of the body. This approach enables a new kind of synergy between spontaneous movement, computation, and sound, thus initiating a technology-fueled fusion of dance and music, which in turn will prompt new cross-fertilizations between choreographic and sonic composition and improvisation. Because our interfaces steer fluctuating emergent qualities through continuous motion in space, they suggest tantalizing syntheses between organisms in motion and the continuous flux of their environment.

I. Stochastic Interactive Algorithmic Music Engines (SIAME): *Fluxations* and *Vortex*

The quasi-granular non-repeating stream of musical sound is created through quasi-algorithmic/quasi-stochastic/quasi-interactive computational engines. [25, 26, 27, 30] Each runs in a loop and combines stochastic procedures (random number generators) and continuous user input, thus: *Stochastic Interactive Algorithmic Music Engines*, or *SIAME*. The *Fluxations* Stochastic Interactive Algorithmic Music Engine (SIAME) paradigm enables the user-performer to manipulate *emergent* (macro) properties of a generated stream of musical sound, properties whose significance would be felt when they change quickly or slowly, as relevant to the perception of medium- and long-range form in fully composed music. [12, 13, 14, 15, 16, 17]

Specifically, the SIAME paradigm may be characterized as Stochastic Interactive Looping (SIL) with the caveat that it does not necessarily produce music that repeats. Instead its constant newness is created stochastically as in Figure 1.
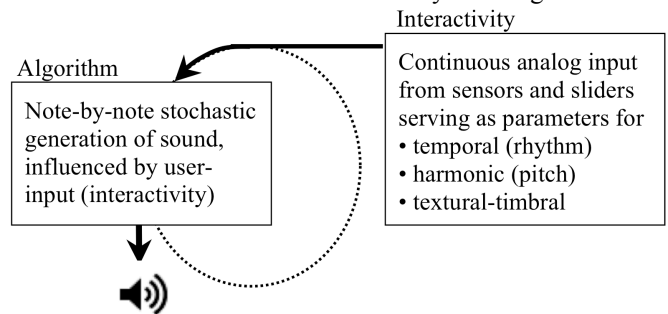

Figure 1. Stochastic Interactive Looping (SIL)

So far, the first author has developed two such SIL engines (SIAMEs). These SIAMEs are called *Fluxations* and *Vortex,* and were programmed in the RTcmix real-time computer music language and prototyped in Max/MSP using the rtcmix~ object, with sliders, dials, and buttons providing input to the RTcmix script, shown in Figure 2.
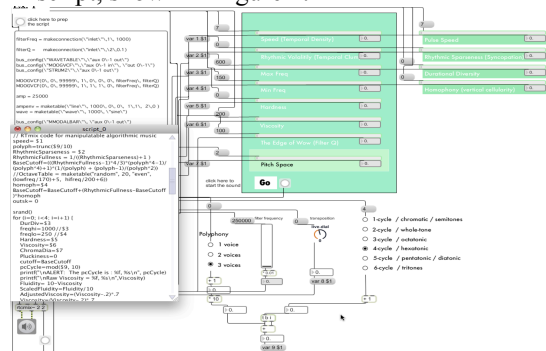

Figure 2. *Fluxations* max patch with rtxmix~ score file script

Fluxations enables spontaneous manipulation of such textural emergent qualities as *viscosity*, *rhythmic sparseness*, *durational diversity,* and *vertical cellularity (rhythmic homophony)* [12, 13, 14, 15, 16, 17]. *Viscosity*, for instance, is illustrated in Figure 3. It is the average sustain of sounds (average grain duration).
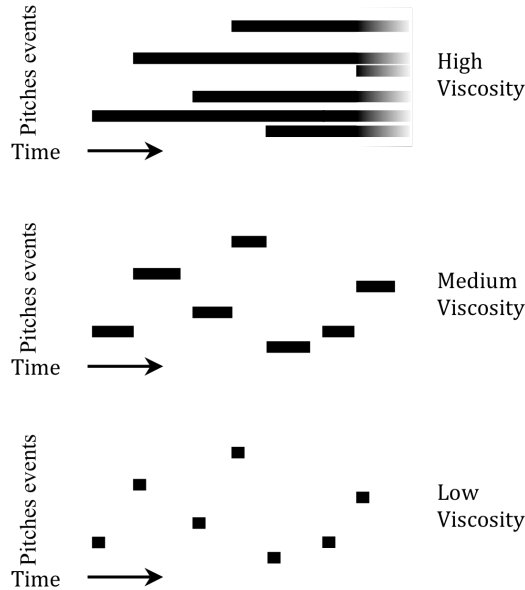

Figure 3. Varying degrees of *viscosity* influence the texture significantly. (Note that all three examples have the same *attack density* and *rhythmic volatility*.)

Also spontaneously manipulated are harmonic (pitch related) emergent qualities of *generative interval cycle, pitch-class cardinality, pitch-class transposition.* [19, 20] These are manipulated in different ways depending on the interface, but always so that continuity of sound corresponds to contiguity in space. For instance, in the iPhone interface, the flux of harmony is controlled through tilting, which affects pitch-class transposition. The degree of continuity (in terms of common tones) depends on how many pitches (set cardinality) are in the pitch set that is currently active, as shown in Figure 4.

The *Vortex* engine enables spontaneous control of *upward*, which is a statistical prevalence of upward as opposed to downward melodic motions, prevelant in the music of Ligeti. [16] Both the *Fluxations* and *Vortex* engines enable spontaneous control of pulse speed, low-pass filter, and instrument timbre.

In the SIAME paradigm, individually sounding musical events are created stochastically, based on parameters drawn from continuous user input. [17] Thus the music is neither composed in the usual sense nor created through musical instruments in the usual sense. Nor is it completely determined by algorithms. Instead it combines aesthetically guided planning, spontaneous movement, and computational brute force in a uniquely productive synergy.
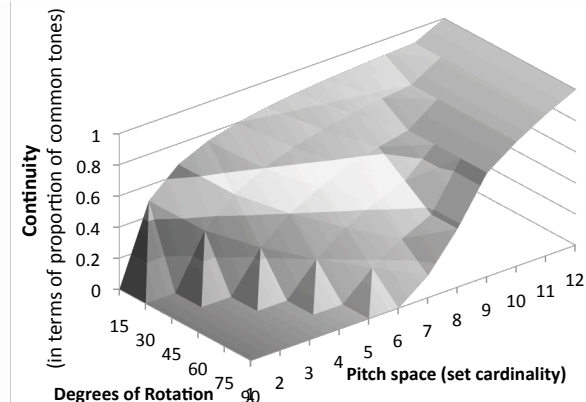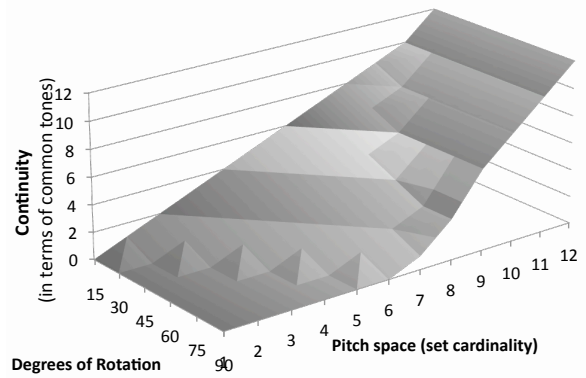

Figure 4. The degree of harmonic continuity per each degree of tilt increases with the size of the *Pitch Space*.

II. CONTINUOUS ANALOG INPUT GESTURAL INTERFACES (CAIGI): STEERING, NOT TRIGGERING

Since the SIAME paradigm does not create individual sounds from discrete gestures, the interface is not based on gesture recognition. Instead it takes continuous analog input to steer and sculpt the stream of generated pre-musical sound. *Continuous analog input gestural interfaces (CAIGI)* therefore continuously detect changes of all or parts of human bodies as they move smoothly (or abruptly) through space. Finger and wrist motions are gauged with flex sensors, sliders, and accelerometers. Whole body movements are gauged with infrared equipped computer vision. The analog interfaces exploit the aspect of musical listening that is computational, specifically that the listening mind consciously and unconsciously, directly and indirectly, immediately and retroactivly, computes various kinds of intensity based on the aural stimulus it receives. [18]

SIAMEs paired with appropriate CAIGIs enable *comprovisation*, which is a kind of musical creativity that relates composition and improvisation in an unprecedented fashion, one which was impossible to achieve with older technologies. *Comprovisation* is compositional in two respects: (1) it involves composing music-generating algorithms as guided by aesthetic concerns, and (2) it may involve the planned choreography of physical movements. Comprovisation is improvisational in three ways: (1) it may

involve spontaneously decided physical movements; (2) planned (choreographed) movements may be spontaneously ornamented with expressive nuanced deviations; (3) the quasi-stochastic algorithm may be regarded as "improvising" since its determining of certain details cannot be predicted in advance (this component could be programmed to function according to improvisational rules rather than stochastically).

III.   THE THREE CAIGI IMPLEMENTATIONS: IPHONE, SENSOR GLOVE, AND KINECT

A.   iPhone

An iPhone interface has been implemented for both the *Fluxations* and *Vortex* SIAMEs. In the iPhone implementation, *Fluxations* and *Vortex* are programmed as separate apps, each of which embeds the iOS implementation of RTcmix called iRTcmix. [21]

With the iPhone interface, shown in Figure 5, left-right twists and up-down flexes of wrist motion are detected through the iPhone's built in accelerometer; these motions are each mapped to a different emergent property in the generated music. Other parameters (mapped to intensities of yet other emergent properties) are controlled through sliders on the iPhone. The *Fluxations* and *Vortex* apps were developed in Apple's Xcode IDE. They are not yet available on Apple's App Store.
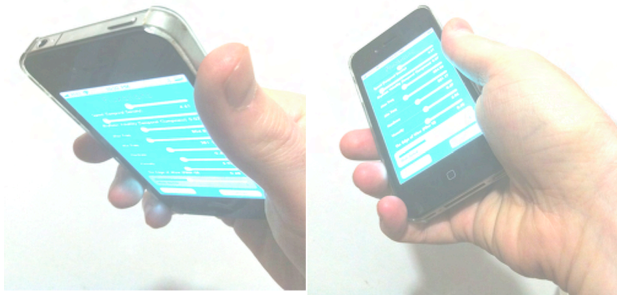
Figure 5.   Input from the iPhone's acceleramter enables expressive interactivity through tilting motions

B.   Wireless Sensor Glove (Custom Designed and Built)

The glove (designed, built, and programmed by the second author) employs a LilyPad microcontroller with an XBee wireless transmitter, sending continuous analog input to a dedicated serial glove Max/MSP subpatch (Figure 6) which routes to the *Fluxations* SIAME running as an rtcmix~ Max/MSP patch on a MacBook Pro.

A flex sensor on the glove's wrist sends analog input to the *Fluxations* SIAME. The flex sensor output can be assigned to any one of *Fluxation's* parameters so that wrist motions can used to steer the intensity of any of its emergent properties.

The glove interface also enables an additional expressive dimension by permitting an exception to the SIAME paradigm: *finger tap triggering* of pitch-stochastic percussive events. The timing of these events is precisely controlled by the user, though their pitch content is generated stochastically in coordination with pitch events created through the SIAME

paradigm. In this way the SIAME paradigm interconnects with one-to-one gesture-to-sound mapping of conventional musical instruments.

C.   Kinect (Microsoft's infrared video camera)

This computer vision based interface uses the Microsoft *Xbox Kinect* 3D motion controller (infrared video camera) to track motion (Figure 7). The camera sensor captures and measures depth data to determine the user's position in 3D space. This continuous analog input is routed to the *Fluxations* SIAME running as an rtcmix~ Max/MSP patch running on a MacBook Pro.

In preliminary stages of this project, Jean Marc Pelletier's computer vision library cv.jit for jitter was used to analyze live data capture from the Kinect camera. Our technology is now significantly refined, however, by the use of OSCeleton through OpenNI with PrimeSense's NITE middleware.
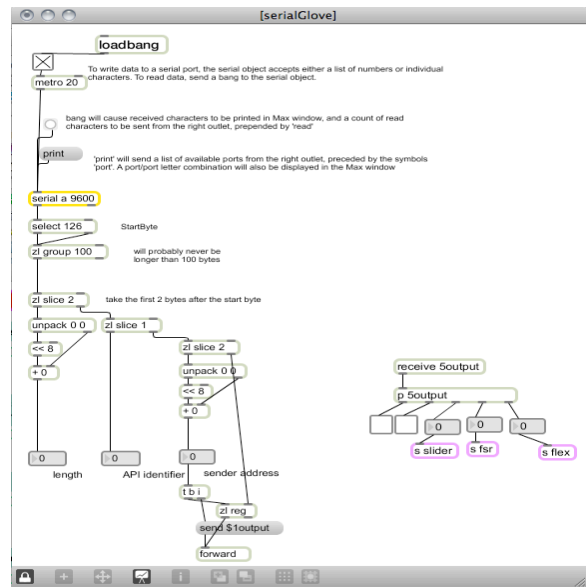
Figure 6.   Max/MSP subpatch which processes and routes analog sensor data coming through the serial port from a slider, a force sensing resister, and flex sensor on the fingers and wrist of the glove

Figure 7.   Microsoft *Kinect* 3D motion controller (infrared video camera)

Using this technology, absolute positions X (horizontal), Y (vertical), and Z (depth) of parts of the human body (head, hands, feet, shoulders, and torso) are continuously poled. For some of these (hands, feet, and shoulders), differences are computed. Each of the absolute and difference computations serves as its own continuous analog input assigned to a different parameter (emergent property intensity) on the *Fluxations* Max patch. Thus the fluctuations of six distinct emergent qualities are manipulated independently through motions of the human body moving smoothly (or abruptly)

through space. For example, as depicted in Figure 8, motions such as flexing the wrist, spreading the feet, turning to a profile, moving forward, moving laterally, crouching, and spreading hands all continuously influence the sound of the music generated by increasing and decreasing the intensity of the various emergent qualities.

Figure 8. Flexing the wrist, spreading the feet, turning to a profile, moving forward, moving laterally, crouching, and spreading hands all continuously influence the sound of the music generated by increasing and decreasing the intensity of the various emergent qualities.

IV.   ARSTISTIC STATEMENT

The link between performance art and interactive technologies such as computer vision is apparent. A reference to the history of minimalism and performance art as it was shaped through the 1960s is necessary to build a connection between past, current and future trends. In the 1960s the performance ideas of John Cage, Merce Cunningham, as well as the "happenings" of Alan Kaprow, and the event-based works of Claes Oldenberg and the Fluxus artists, greatly influenced the artistic scene of New York. A "minimalist aesthetic" was felt throughout the arts including cinema, new theater, conceptual art, performance, and video art. The term *happening* was coined by Alan Kaprow in the late 1950s to describe event-based performances shaped by the participation of the audience that occurred in physical spaces such as abandoned factories, lofts, parks, buses and so no. John Cage's experimental performances at Black Mountain College in the late 1940s constitute the first Happening events. The minimalist aesthetic minimized the sense of authorship of the artwork and emphasized art as a collaborative, democratic social experience, through collaborative indeterminate works such as Riley's *In C* as well as an unmediated art, in which the participation of the performer or viewer was as important as that of the artist in the completion of the art work. Influenced by Cage's indeterminacy, chance operations and audience involvement, Kaprow among others, attempted to minimize distinctions between audience and performer. Kaprow believed that "art is a continual work-in-progress, with an unfolding narrative that is realized through the active participation of the audience." Furthermore, the theories of Marshall McLuhan whose philosophy may be summarized in the phrase "the medium is the message," and Buckminster Fuller, prompted artists to seek spiritual transcendence, by examining the "capabilities" and physiology of the medium.

Since 1960s, new and resurgent philosophical developments enable a reframing of the artistic relation of spontaneity to the body, to technology, and to media. The *Fluxations* comprovisational paradigm enables the flexibility to spontaneously create sudden attention-getting changes as well as nuanced atmospheric changes to the audible properties of the stream of musical sound. In the artistic domain, such nuanced fluctuations may serve as "vectors of transmission for feeling" as described in the metaphysics of Whitehead, and recently applied to the aesthetics of media. [22, 29] Through new technologies such as ours, expression may be embodied in physical motion. Thus an artistic philosophy can now be synthesized with theories of embodied mind developed by Lakoff and Johnson and the philosophies of flux and process articulated by Heraclitus, James, Bergson, and Whitehead.[1] [1, 2, 3, 5, 7, 11, 29] Considered in this light, the capabilities and physiology of the medium now suggest pure physicality as a path to spiritual transcendence through artistic expression.

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APPENDIX

Demonstrational videos of *The Sound and Touch of Ether's Flux* can be viewed at http://vimeo.com/album/1872304. To hear the first author's comprovisations made with the *Fluxations* technology, and learn more about his scholarly and creative work, visit his website: http://www.joshuabanksmailman.com. To learn more about the second author's installations, wearables, and interactive art and technology, visit www.copperbluemedia.com and www.sofiart.com.