NOTATED CONTROL AS COMPOSED LIVENESS IN WORKS FOR DIGITALLY EXTENDED VOICE

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ABSTRACT

This study argues that learning of varying control mappings in digitally extended voice works imbues body and memory into liveness. First, the author's extended voice practice is discussed. The Abacus, a unique, microphone-mounted, Arduino Teensy-based musical interface, controls granulation of live vocal samples. There are sixteen pre-composed mappings of Abacus control data (eight toggle switches) to granulation parameters, and mapping changes regularly. An animated screen score provides manual toggle control instructions, which didactically supply information on current mapping. Subsequently, discussion turns to works by other extended voice practitioners and to a larger context of screen scores and musical games. Building outward from notions of vocal intimacy and presence, extended voice uses technology for temporal exploration of timbre. Screen scores and musical games highlight learning, but typically utilize an unchanging control mapping throughout the piece or game. My work constitutes a novel intersection of these practices, arguing that repeated, notation-driven learning of the action-sound relationship thematizes complex interactions between body, temporality, memory, and presence.

1. INTRODUCTION

Voice is a complex phenomenon, but embodied presence is usually considered a crucial part [7, 17, 19]. Recent scientific-musical studies of voice begin to address connections between embodiment and liveness, but frequent division of labor between technologists and vocalists hinders integration of performative and technological methodologies. By contrast, extended voice practitioners, including Andrea Pensado, Ami Yoshida, and the author, synthesize technological, compositional, and improvisational methodologies and thus directly address liveness during electroacoustic performance.

This study discusses two of the author's recent compositions for extended voice: "couldn't" (2016) and "for ami" (2016).[1] First, the extended voice setup is discussed in the context of "couldn't." Subsequently, I discuss the use of a screen score of control instructions as a method of composing liveness in "for ami" (2016). Finally, these compositions are related to other extended voice works and to larger discussions of screen scores and musical games. I argue that screen score works for extended voice create a novel form of liveness by employing the liveness-through-didacticism of screen scores and by questioning the connotations of intimacy, embodiment, and presence typically ascribed to voice.

[1] Excerpts at http://kmwarren.org/tenor17.html

2. VOICE, ABACUS, MAX/MSP

2.1 Live Vocalization

My vocalization in my voice-electronics compositions includes normative singing, occasional speech, and frequent extended vocal techniques. Typically, the voice provides fodder for the granulation system and tries to achieve a dialogue with the electronic sounds, but feature extraction can impart structural importance to particular vocal sounds as well. For instance, "couldn't" uses undertone singing, or vibration of the false vocal folds at one-half or sometimes one-third of the fundamental frequency, to trigger changes between the two patch states. Feature extraction in MaxMSP identifies undertone singing through its distinctive ratio (2.1-2.6) of spectral centroid to fundamental frequency.

Pitched	
Harmonics	slow alternation [u] (har. 1-2 above)
Undertone sing	false vocal folds (har. 1-2 below)
Ululation	fast chest-head register alternation
Inhale sing	pure / noisy (resembles bitcrush)
Lip squeak	upper teeth, moist lower lip, inhale
Pursed lips	pitched squeak, (sub)audio rate
Pressed squeak	high in vocal tract / post-nasal
Unpitched	
Duck call	air against mid-back hard palate
Glottal stop	beginning / end of note
Lip buzz	usually sub-audio rate / bursts
Press / fry	bursts, can merge into audio rate
Epiglottal click	in- / egressive, single or sequence

Table 1. Extended vocal techniques (selected)

Many extended vocal techniques are very quiet. These non-normative vocal sounds frequently originate from non-larygneal oscillators such as lips with teeth, air against the hard palate, or saliva against cheeks. My work increasingly tries to attend to the mouth as origin of these tiny, detailed sounds. The novel control interface called the Abacus is mounted directly on the microphone clip; the necessity of bringing the hand near the mouth in order to control draws audience attention toward the mouth and its small sounds. “Couldn’t” and earlier works include dense electronics, while the voice purposefully struggles to co-exist by imitating the electronics’ rhythm or timbre. While this voice-electronics competition is evocative, it is not ideal for drawing attention to small, mouth-originating sounds. Thus, “for ami” and more recent works use primarily less-dense electronic textures and aim for a gentler or more subtle sound world.

2.2 Abacus

The Abacus is a novel interface used for controlling digital processing of voice. It consists of an Arduino Teensy, which sends Serial information via USB connection, along with eight toggles, four potentiometers, one button, and one LED. Thermoplastic affixes the Abacus to a Shure SM-58 microphone clip. Crucially, this interface permits simultaneous vocalization and control.

Figure 1. Abacus interface

Toggle 1	Toggle 2	Toggle 3	Toggle 4
listen for undertone singing	solo one processed voice	live voice: random processing	record live voice/ processed sound
Toggle 5 (voice 1)	**Toggle 6 (voice 2)**	**Toggle 7 (voice 3)**	**Toggle 8 (voice 4)**
State 1 granular/ not | **State 2** follow/ ignore rhythm			

Table 2. Abacus, control mapping in “couldn’t”

The streamlined design of the Abacus is conducive to varied control mappings. Within my piece “couldn’t,” the mapping of Toggles 5-8 varies with patch state; in one state they control timbre, and in another state, rhythm and density.

An early control mapping scheme, developed in 2015-2016, is much more parametric. In this mapping scheme, Rhythm, Pitch, and Noise are three control spaces which route toggle pairs 3-4, 5-6, and 7-8 to distinct sub-parameters such as Meter, Interval, and Timbre. Extended vocal techniques, identified through feature extraction, trigger navigation among the three overarching control spaces [16]. This mapping yielded musically dissatisfying results; complexity prohibited control fluency and expressivity. This led to ongoing research into streamlining control mapping, as in “couldn’t,” while still varying mappings during the composition, attempted initially in “couldn’t” and more meaningfully in “for ami.”

2.3 Real-Time Processing in MaxMSP

Real-time processing of live vocal samples occurs in MaxMSP. Several types of processing occur: rhythmic granulation, pulsar granulation (i.e., streaming an alternation of grain and silence [11]), and wavetable synthesis.

Processing of the live signal, rather than live samples, is also possible, using techniques such as transposition, distortion, and delay. The patch is modular, such that any signal (voice, granulation, or wavetable synthesis) can be heard ‘clean’ or sent to live processing and/or subsequent granulation. The overall aesthetic goal is to explore similarities between vocal and digital sound worlds, particularly the shared noise potentials of each.

My piece “couldn’t” is fairly rigid in its implementation of pulsar granulation. A few possible values exist for grain start time and length, and wait time between grains is always 10 ms. Slight, probabilistic jitter in grain start time, length, and playback speed, calculated independently for every grain, provides some musical interest. Nonetheless, this rigidity of pulsar granulation settings contributed to a desire for more flexibility in later works.

Start time (0 - 4000 ms)		Len (ms)	Wait (ms)	ST, len jitter	Speed jitter
400	1800	30	10	10% chance +- 3% ST and/or len	67% chance +- 2% speed
1000	2100	80			
1500	2200	100			
1700	2800	140			

Table 3. Pulsar granulation parameters, "couldn't"

3. NOTATED CONTROL

My recent piece “for ami” employs vocalization, Abacus, and live sample granulation in MaxMSP, with frequent variations in the Abacus control mapping. The Abacus makes it easy to vocalize and control at once, so the primary goal in this piece was to go a step further and attempt to learn the changing control mapping in order to explore liveness.

“For ami” is nine minutes long and consists of a series of miniatures (durations 0:15-2:00) separated by pauses. Each miniature represents a different control mapping. Some miniatures have a pre-composed duration, and others have a free duration such that I trigger the end of the miniature ad lib. The piece is inspired by and named for extended voice practitioner Ami Yoshida. Her album *Tiger Thrush*, consisting of 99 untitled miniatures, is a meditative, inspiring exploration of vocal and electronic timbre.

3.1 Mappings

There are sixteen pre-composed control mappings. Each allows control of some parameters of pulsar granulation, and assigns other parameters uncontrolled values (either constant, or simple LFO-varied). Most mappings do not map control data directly or uniformly to parameter values, but rather to LFO parameters for regular temporal variation of granulation parameters. This sculpting of complex LFOs yields fine control of timbre. In addition, mappings incorporate variable gain gating on the granulated signal, yielding a more ‘human’ sound which includes rests. Finally, each mapping also includes some associated toggle instructions for the screen score.

<table>
<tr><td colspan="5">(values in ms unless otherwise noted)</td></tr>
<tr><td></td><td>tog 1-2</td><td>tog 3-4</td><td>tog 5-6</td><td>tog 7-8</td></tr>
<tr><td>1</td><td>live vox, pan alt. = 0.5, 1, 4, 10 Hz</td><td>ST = 400, 1600, 2800, 3800</td><td>len = 3, 10, 25, 41</td><td>wait = 5, 30, 70, 90</td></tr>
<tr><td>2</td><td colspan="2">live vox, # transposed versions = 0, 1, 2, 3; # cents = -75, -20, 35, 60</td><td>ST = 200, 320, 3520, 2640</td><td>len = 2, 8, 12, 18</td></tr>
<tr><td rowspan="2">3</td><td colspan="2">alternate ST_1,2</td><td rowspan="2">len, alt. (5-12) time = 160, 600, 980, 2300</td><td rowspan="2">wait, alt. (20-30) time = 140, 550, 900, 2000</td></tr>
<tr><td>ST_2 = 0, 480, 1200, 2000</td><td>alt. time = 80, 300, 500, 1200</td></tr>
<tr><td rowspan="2">4</td><td colspan="2">len, wait LFO</td><td colspan="2">ring mod. on LFO</td></tr>
<tr><td>rate = 3, 20, 47, 80 Hz</td><td>depth = 1, 10, 50, 100 Hz</td><td>rate = 5, 8, 10, 20 Hz</td><td>depth = 0.01, 0.1, 1, 4 Hz</td></tr>
<tr><td rowspan="2">5</td><td colspan="3">ST, len LFO (alt. slow-fast)</td><td rowspan="2">alt. long-short wait, duty cyc = 0.6, 0.8, 0.9, 0.95</td></tr>
<tr><td>duty cycle = 0.5, 0.6, 0.7, 0.9</td><td>rate_fast = 1.9, 5.4, 11, 36 Hz</td><td>depth = 2, 10, 20, 40 Hz</td></tr>
<tr><td rowspan="2">6</td><td colspan="4">4/4, 48 bpm (mute, un-mute alternating beats)</td></tr>
<tr><td>beat 4 ST = 800, 1600, 2400, 3600</td><td>beats 1,3 len = 1, 4, 8, 16</td><td>beats 2,4 len = 3, 5, 10, 30</td><td>b. 2,4 time til mute = 10, 50, 100, 300</td></tr>
<tr><td rowspan="2">7</td><td colspan="4">4/4, 132 bpm</td></tr>
<tr><td>beat 1 ST = 0, 400, 600, 800</td><td>beat 2 ST = 1200, 1400, 1600, 2000</td><td>beat 4 ST = 3200, 3400, 3680, 3960</td><td>beat 3 wait_short = 5, 10, 18, 36</td></tr>
<tr><td rowspan="3">8</td><td colspan="4">4/4, 21.6 bpm (muted, occasional 16ths sound)</td></tr>
<tr><td colspan="2">alt. ST_1,2 every 40 ms</td><td rowspan="2">len_1,2,3 (alt. every 152 ms) = 1-2-3, 2-4-6, 4-8-12, 8-16-24</td><td rowspan="2">wait_2 (alt every 600 ms) = 10, 20, 50, 100</td></tr>
<tr><td>ST_1 = 40, 360, 560, 720</td><td>ST_2 = 800, 960, 2440, 2720</td></tr>
</table>

Table 4. Control mappings 1-8, "for ami"

In all mappings, the eight toggles are treated as four pairs, each outputting values 0-3. Mappings 1-2 scale toggle-pair values more or less directly to values of live vocal signal processing and grain start time, length, and wait. In the other mappings, however, toggle-pair values contribute mostly to time-based variance of parameters, for instance through low frequency oscillators (LFOs) or rhythmically metered variance.

This routing of control data to rate of change rather than to discrete parameter values comprises a second-order treatment of control data. This yields a more complex and musically pleasing sound. Often, processing changes are only discernible after several seconds of listening. This is a purposeful compositional decision which slows the performance pace, lends a meditative quality, and creates time for purposeful decision-making about exact content and timing of vocalization.

On loading the patch, a random order of the sixteen mappings is generated, including possible nonconsecutive repetition. The unpredictable order of the sixteen mappings renders them surprising enough to require relearning during performance.

3.2 Screen Score

An animated screen score presents real-time instructions for manual operation of the Abacus toggles. These instructions are didactic in nature, uniting with the audio result to progressively reveal information about the current mapping. The large central toggles report current state and show toggle instructions, with a red-yellow-green countdown to enable performer preparation. The smaller toggles in the upper right corner provide redundant information, namely the summation of a few recent and upcoming toggle steps. This animated score is viewed on a laptop screen during performance and, if circumstances permit, may also be projected onto a larger screen visible to the audience.

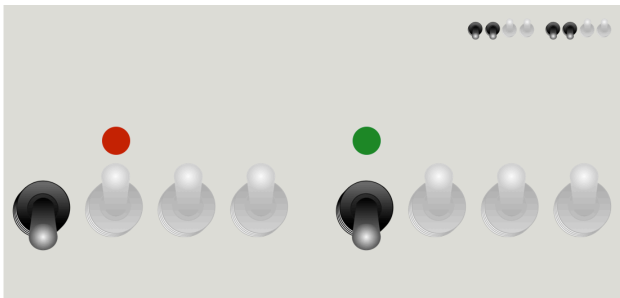

Figure 2. Video score screen capture, "for ami"

In combination with the audio output, the screen score serves a didactic function. Each mapping carries associated video instructions which indicate the content of the mapping. For instance, in mapping 7, the tempo and meter are rapidly audible. The first instructions might require toggles 1-2 = 0 then 2 (as binary numbers, separated only by one flip of toggle 1) to illustrate the sonic difference on beat 1. Next, similarly, the instruction might require toggles 3-4 = 0 then 2, demonstrating the sonic change on beat 2.

Some randomization of instructions occurs, so that even miniatures using the same mapping are distinct.

Recording of live samples also complicates matters. There are up to twenty distinct granulation voices which may be processing different buffers, in any combination. Typically, I record several new buffers during the piece, where audio source can be either the vocal signal or, cyclically, the granulation output.

To clarify, the screen score only notates manual control gestures. Vocal material, including techniques shown in Table 1, is fully improvised. I do not enjoy realizing vocal notation because I feel that accuracy takes precedence over expressivity. Thus, "for ami" notates control gestures and utilizes vocal improvisation.

4. COMPOSED LIVENESS

Liveness in "for ami" is premised on several key assumptions. First, Abacus-based control gives a greater sense of presence in the moment than would a non-interactive system. Second, varying the control mapping several times during the piece constitutes an opportunity for performer learning, which further enhances liveness. Third, as in many musical systems and idioms, some improvised deviation from the score is possible once the rules are well enough understood, comprising yet another layer of liveness.

It is widely acknowledged that digital interfaces are uniquely powerful because they allow myriad relationships between physical action and sound. "For ami" acts directly on this possibility space. Cyclical learning – starting afresh with each miniature – foregrounds liveness, and learning is incentivized by the possibility of improvisation with the learned mapping.

Extended voice is unique in treating memory as a part of liveness. Granulation of live vocal samples, for instance, is intended partly to confuse listeners' short-term memory of vocal utterance. A noisy sound which initially seems very remote from voice may, through variation in granulation parameters, be gradually revealed to be vocal in origin. In other words, timbral evolution makes electronic timbres present, while the acoustic voice, which traditionally connotes intimacy and presence, becomes a thing of the past.

Timbral similarities between voice and electronics emerge despite the time-lag implicit in live sample-based work. Unlike parallel processing of voice, for instance vocal pitch-following to yield fundamental frequency of an oscillator, live samples take a few seconds to record, and then several more seconds to process using manual control. In other words, liveness in extended voice is a dialogue with a digitized version of oneself from several seconds ago, and control of this digitization may in turn influence the live vocalization.

5. DISCUSSION

This section addresses Ami Yoshida's album *Tiger Thrush* (2003) [18], which inspired the author's composition "for ami," and Andrea Pensado's album *Without Knowing Why* (2015) [9]. Yoshida varies pauses and durations within and between miniatures to create novel temporal interactions between extended vocal techniques and electronics, while Pensado's work is unique among extended voice for its rapid variation among noise timbres. Thus, both Yoshida and Pensado dually explore temporality and timbre. Similarly, extended voice at large links timbre and temporality by including memory within performative liveness. The voice has the potential to be digitized at any moment, making it an instrument of the past, while electronics indicate the present.

This section will also address studies of screen scores and video games. Whereas these two media aim for control consistency and transparency, extended voice employs varying control mapping, which unsettles intuition and renders the body strange, just as voice is rendered strange through timbral exploration and digital processing.

5.1 Yoshida, *Tiger Thrush*

Ami Yoshida's album *Tiger Thrush* consists of 99 untitled miniatures. Yoshida's self-defined style of "howling voice," or quiet speaking and screeching sounds often produced through inhalation or high-pressure exhalation, joins found objects and environmental background sounds in this album.

Tiger Thrush manifests the timbral-temporal exploration common in extended voice. Some tracks, such as #8, are single vocal utterances of only a few seconds' duration. Though such tracks initially seem to function as non-structural palate cleansers, their presence throughout the album suggests that something more is at play. By contrast, other tracks, such as #5, loop a single vocal phrase, either mono- or polyphonically, for several minutes. At first blush, these longer tracks seem important formal anchors within the album. Nonetheless, the stillness and persistence of *Tiger Thrush* gradually suggest an inversion: micro-tracks come to read as intense sound bytes which eschew embellishment, while longer looped tracks provide a sense of familiarity and pad the more concise vocal statements.

Yoshida's temporal exploration of timbre is also apparent in the non-vocal tracks, of which #45 is a prime example. This track, consisting of looped, high-frequency background noise, follows shortly on the heels of the previous track and lasts almost five minutes. Track #45 utilizes the same room noise present in Track #44, which contains several substantial pauses, but articulates a new musical statement because of its length and subtle variation of loops. Through slight manual adjustments to the time bounds of the loop, the listener begins to question whether the sound is changing or if this is in fact a perceptual mirage. Yoshida's intermingling of silence and continuity serves to make timbre strange and to unsettle short-term sonic memory.

Delicate reverb and some reversed sounds subtly remind listeners of the presence of technology. Unlike many extended voice practitioners, Yoshida is minimal in her demonstration of technological control. The subtle compositional decision of whether to conclude a track partway through or at the end of a loop is one point of engagement with the technology. Other tracks underscore the sonic role of the technology itself. For instance, in Track #49 Yoshida performs a melody consisting of distorted microphone pops.

5.2 Pensado, *Without Knowing Why*

In her 2015 album *Without Knowing Why* and her recent live performances, Andrea Pensado explores a variety of voice-noise interactions. The titular character in "Rondo con Andreita" is likely the doll with which Pensado sometimes performs (e.g., Back Alley Theater, Washington DC, Sep 2014[2]) and which is mentioned in the album liner notes. "Rondo" and the Back Alley performance are distinct versions of the same material, where the A section of the rondo form consists of quiet speech, little processed, while the alternating contrasting sections are much noisier. These noise sections are characterized by rapid timbral changes (rate of change = 2-4 Hz). The noise initially follows the melodic and/or rhythmic contour of Pensado's voice but in later non-A sections grows more independent and increasingly masks the voice.

The humor and weirdness of Andrea Pensado's use of, apparently, a doll named "little Andrea" augment the questions of control raised by the work. The voice can be used for both expression and control, and these functions sometimes become indistinguishable in Pensado's sound. The apparent spectral following which drives synthesis is evidence of hands-free vocal-control work. Yet Pensado also uses her hands to animate the doll as though it is speaking or listening, and these motions seem to trigger sonic changes. The doll may contribute to the sense of hand-sculpted rhythmic detail, or this audio-visual link may be completely imagined. The rapidity of timbral changes further obscures control source.

Notably, although harsh noise timbres prevail, compositionally-trained phrasing is also apparent. Gestures are not random, but rather occur within some structure. For instance, the garbled, chorused speaking voice beginning at 3:07 in the left channel uses quantized, almost vocoded, frequencies emphasizing a range of about a minor sixth. Noise sections do not begin abruptly, but are instead prepared by brief, growing interruptions often panned centrally.

Pensado's frequent changes in electronic timbre are unique in the landscape of extended voice. This protean quality may arise in part from deep familiarity with the capabilities of her technology. Though Pensado identifies as an improviser who takes a "highly intuitive" approach to "using Max as her main programming tool" (from Pensado's professional bio), her utterances nevertheless seem tailored to what the patch does well, for instance speech with larger than normal frequency range to provide interesting fodder for noise synthesis.

[2] https://www.youtube.com/watch?v=KspVGrJrhpg

5.3 Screen Score Works and Musical Games

Screen scoring is valued for its unique musical possibilities, including audience interaction [2], novel methods for representing time and texture [4,13], and conduciveness to formal re-combination and material generativity [15]. Screen scores innovate in musical expressivity, but, like traditional notated music of the Western canon, they often make certain assumptions about time and liveness, or lack direct connections to physical action. For instance, Kim-Boyle praises screen scores' performative and compositional metaphor of navigation along a pathway [6], but this seems to rely on assumptions of time as a simple forward flow.

Musical games take a related approach. Pichlmair and Kayali's taxonomy of musical video games includes two overarching types, Rhythm and Instrument, and seven important features, including Active Scores, Synesthesia, and Play-as-Performance [10]. Game-salient types of learning, such as "just in time" learning, are a novel synthesis of past, present, and future: instructional content, tailored to past experience, is delivered to aid completion of a near-future task [3]. Similarly, game pieces by composer-researchers treat games as toys; by learning the physical rules, or affordances, of these toys, players can achieve a flow state of creative interaction [5, 14].

Though screen scores and video games may employ different objects – acoustic instruments versus game controllers – both emphasize unchanging action-screen relationships throughout the piece or game. For instance, "natural mapping" of video game control, i.e., similarity between control action and animated game result, aims to create a smooth progression through states of learning, improvement, and expertise within the single control mapping [12]. On the rare occasion when control mapping does vary, for instance variation in control degrees of freedom to allow fluid motion through game space, this is treated as 'under the hood' algorithmic information unnecessary to the performer [8].

In contrast to the control transparency intended in screen scores and video games, extended voice is motivated by a desire to make the body strange. This exists first in exploration of vocal timbre through electronic extension of the voice, but also in varying control mapping. Many extended voice practitioners use minimal electronic setups such as laptop with one controller, where digital patch states govern variation in control mapping. Thus, the same physical action – pressing a particular button or flipping a particular toggle switch – could yield very different sonic results at different moments in the performance. This counteracts embodied intuition. The body is decentralized and becomes a thing of the past, and focus goes instead to digitized sound in the present.

Notated control is a form of choreography intended to inspire novel performance temporalities. In the context of my interface the Abacus, this choreography is seemingly minute in that it primarily addresses the fingers, but it has much broader ramifications. Bringing the hand close to the mouth draws attention to the mouth, an often overlooked musical site (distinct from the larynx). This renewed attention to mouth serves to thematize the complex interactions of embodiment and temporality. The frequent and repetitive vocal digitization in extended voice practice places body in the near past. The body is an input to, rather than an acting agent within, the present moment.

6. FUTURE DIRECTIONS

Extended voice practitioners explore novel forms of liveness and performance temporality, often through composed but improvisation-conducive technical methods, e.g., varying digital patch state to re-map control information. This is particular to extended voice because practitioners work within and against traditional assumptions that voice is intimate and present. They undertake prominently temporal variation of vocal timbre and explore voice-electronics as novel instrument.

Ongoing performance work will clarify the interactions between vocal expressivity, digital noise, and non-verbal communicative acts. My vocal work rarely uses text, so text-based theoretical precedents, including Barthes' notion of the 'grain of the voice,' are not directly relevant. Instead, I build upon physical vocal research which treats the voice itself as technology which is malleable for creative purposes [1].

Further research is needed into intersections between extended voice, screen scores, and musical games. Extended voice offers a novel response to notions of embodiment and presence, but research is needed regarding the responses of other musicians or of gamers to control mapping variation. By contrast, screen scores and game pieces offer the advantage of expertise through repetitive learning. While these media yield exciting possibilities of musical expression, continued study is needed into the contributions of complex forms of embodiment and liveness.

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