Beacon: Exploring Physicality in Digital Performance

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Abstract
Live performances which involve digital technology often strive toward clear correspondences between distinct media modes, particularly those works which combine audio and video. Often, the process of creating and executing such performances involves mapping schemes which are encased within the digital system, producing content which is tightly synchronized but with relationships which can feel rigid and unexpressive. Within this paper we present a collaborative process between visualist and musician, which builds toward a method for promoting co-creativity in multimedia performance and prioritizes the performer's physical presence and interaction with digital content. Through the development of two autonomous systems, a novel physical interface and an interactive music system, we summarize our creative process of co-exploration of system capabilities, and extended periods of experimentation and exploration. From this experience, we offer an early-stage framework for approaching engaging digital audiovisual relationships in live performance settings.

Author Keywords
Digital performance; co-creativity; tangible user interfaces.

CCS Concepts
•Hardware → **Tactile and hand-based interfaces; •Applied computing** → *Sound and music computing;*

Introduction

The physical and the digital share a performance space with increasing frequency. We attach sensors to dancers (e.g., [1]), we mount cameras in the rafters (e.g., [8]). We map our media onto our bodies, our screens, and our speakers, we utilize computer technology to extend technique, build novel relationships with media and technology, and produce richer performances [4]. But the physical-digital contract is too often considered a system with which to send information from one media or discipline to another, rather than a framework within which we can collaborate in new ways.

One of the byproducts of this development is that the computer, as it extends our capabilities, at the same time runs the risk of removing expressivity from our hands [6]. Technology is commonly used in ways which allow any spectator to experience a piece as a polished, safe production, with little regard for what expressive or collaborative capabilities might have been sacrificed in the interest of ease or security. Often culminating in one-to-one mapping, this synchronous input-output relationship is digital mickey-mousing, a way for a secondary source of content to be driven by the primary element of performance. The visual content becomes a music video to accompany musicians, or music becomes the soundtrack for a dancer. This approach abandons the rich potential for experimental performances before it even begins. Though this condition can be observed in nearly all facets of performance, audiovisual pieces are a prime example of both the potential for engaging new work as well as the pitfalls of poor or misguided design.

In *Beacon*, aural and visual content is considered as expressive material which evolves together over time, shaped by both the digital system's properties as well as the agency of the human performers. Several guiding principals have been employed in order to explore the possible performance dynamics in this work, including exploring physical and digital system capabilities, identifying and experimenting with audiovisual relationships, developing compositional form, and building toward an audiovisual performance framework. In the following sections, we will discuss these techniques and the resulting consequences for composition, instrument design, and performance.

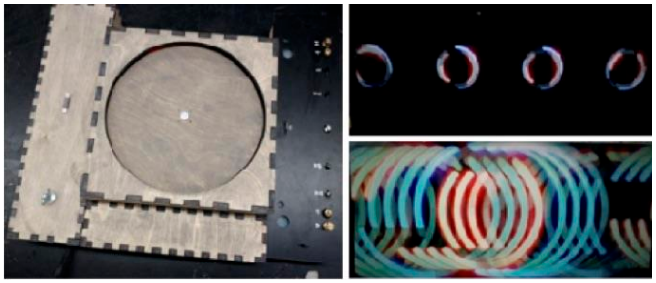

Figure 1: Distaff, a visual instrument.

Beacon

Beacon is an audiovisual performance for electronic musician and live visualist. The audiovisual paradigm presented in the work is decidedly musical, though each agent acts with autonomy, and the resulting dynamics embody a reconsideration of both visual music and soundtracks. The visualist and musician are linked through more than their dynamics; the visual system itself is amplified, contributing to the shape and dynamics of the sonic material.

Beacon has been performed twice to date, in very different spaces. The first performance was tailored to an 8-channel sound system at the 2017 Root Signals Festival (Georgia

Figure 2: Fingertip pressing on the Distaff. Photo: NIME 2017 / Stengade.

Figure 3: Operating the Distaff. Photo: NIME 2017 / Stengade.

Southern University, Statesboro, Georgia, United States), and the second performance was held at the NIME 2017 conference (Stengade, Copenhagen, Denmark).

All of the visual content for the piece is produced live on a specialized visual instrument, the Distaff [14], which requires the performer to focus on gesture, feedback, and physicality within the collaborative space (see Figure 1). With core mechanics pulled from a Technics turntable, the visualist must control the instrument's rate of rotation through power and pressure, allowing the object to effectively "push back" against the fingertips (see Figures 2 and 3). With physiological phenomena such as reverse-rotation (the "wagon-wheel effect") and persistence of vision considered, the output of the instrument ranges from fluid textural movements to stuttered, strobing lights; both ends of the spectrum geared toward immersing the viewer in an unfiltered physical experience of the senses.

The audio engine is a prototype built on the audio programming language SuperCollider [9]. An example of code is shown in Figure 4. The prototype aims at working with the sound material that comes in as audio generated from a performer, in the tradition of Schaeffer's *musique concrète* [12]. This prototype is built within an overall system, MIRLC, that explores the use of Music Information Retrieval (MIR) in live coding (https://github.com/axambo/MIRLC). The sound of the fingers interacting with the instrument as well as the inner mechanical sound produced by the device are captured with a lavalier microphone mounted inside the Distaff system. This input signal controls the sound at different levels: from no modification of the audio signal, to the use of the audio signal to control parameters of digital audio filters or other audio signals. In this prototype, we explore unidirectional control (i.e., from one audio signal input to one audio signal output). In the future, we are interested

```
1  // INSTANTIATION
2  ~distaff = ~audioin(0)
3  ~rew = MIRLCRew.new(~distaff)
4
5  // GET AUDIO FEATURE VALUES
6  ~onsets = ~rew.onsets
7  ~beats = ~rew.beats
8  ~amps = ~rew.amps
9
10 // PURE AUDIO
11 ~bypass = ~rew.bypass
12
13 // EFFECTS
14 ~rew.reverb(~onsets)
15 ~rew.pingpong(~onsets, 2)
16 ~rew.noisegrain(~onsets)
17 ~rew.reverb(~amps)
18
19 // INSTRUMENTS
20 ~rew.kickdrum(~beats)
```

Figure 4: An example of code of MIRLC, the audio engine.

in exploring mutual interaction. This refers to bidirectional control, and therefore the use of feedback is welcome. The challenge here is to frame how to modify a visual instrument that is not designed to generate sound.

Physicality in Digital Performance

In order to move away from pure data mapping and toward a more human-centered approach to multimedia performance, a strong focus on the performer was embraced. Laptop performance [3] diverges from more traditional performance practices in that it is less physical in terms of content actuation, and the mechanics of the system are often opaque to audience members. Particularly within the traditions of acoustic musical practices such as chamber ensembles, the ability to "read" one another throughout the course of a piece is highly dependent on visible physical cueing, which can be lost if too much attention is required by a glowing screen. The field of new music increasingly

turns its focus toward this issue, producing New Interfaces for Musical Expression (NIME, see http://nime.org), which facilitate corporeal involvement in computer music. In more recent years, this notion has been explored in terms of "embodiment," or "embodied cognition," [5] wherein participants and spectators perceive music through multiple senses, and the relationship between bodily movement and conceptual meaning are closely tied through the act of gesturing [11, 13].

The concept that the body serves as a bridge between the physical world (external) and perception (internal) places gesture, physicality, and expression in a reciprocal meaning-making process which can become complex, detailed, and layered with the proper tools and training. Gestures carry with them cultural and social meaning in their physicality [7, 10]. Not only do these movements convey meaningful information to other performers and the audience, they also represent the connective tissue between the performer and instrument, and illustrate the functioning relationship between the two [2, 13]. The visual nature of these actions is a crucial element of traditional musical performance, as ensemble members read each other throughout the course of a work and the audience interprets the emotions, efforts, and other non-verbal communications of the performer. It is therefore important to us that physical instruments are employed in order to bridge the human and digital systems, both to provide tangible means for digital production as well as convey meaningful gestural information to the audience.

Utilizing Space

One of the advantages of computer-aided art is the seemingly endless array of creative capabilities, both in terms of content generation and manipulation. The compositional space in new media works is often limited only by the desires and choices of the composer, who strives to create a believable and immersive experience through the curation of the material with which they are working. In *Beacon*, the aural and visual components are required to share a physical and conceptual space, one in which they can evolve separately while still influencing each other and existing in an experience which feels authentic. In order to ground the experience temporally and spatially, natural sounds are exploited within the performance space. By amplifying the sounds of the visual instrument, purposeful and incidental content is integrated into the sonic palette available to the musician, and can be included or disregarded as deemed appropriate. The visualist can intentionally contribute to the musical aspects of the piece by employing her fingertips or nails on the spinning wooden platter, or tapping rhythms on the enclosure. However, the inherent sounds produced by the motor and the actuation of the instrument are continually available to influence the direction of the piece, meaning that mistakes, accidents, and errors are an uncontrolled contributor to the work. The physical affordances of the system enable expression, but also introduce a level of analog risk into an otherwise stable digital system.

The sonic exploration of the physical properties of the visual engine can be explicitly combined with the sonic properties of the performance venue. Spatial audio is a relevant approach in live performance that brings materiality to the space and can range from a standard stereo panning to a multichannel spatialization. This approach brings the opportunity to create meaningful mappings for both the performers and the audience. At the same time, aesthetic and practical reasons determine the shape of the compositional decisions.

Evoking Themes Through Material System Properties

The content for *Beacon* is driven by structured improvisation and experimentation with the instruments at hand. We argue that, in the same way that a cellist learns the curves and textures of his instrument, intimacy with certain digital systems is crucial in the facilitation of compelling computational art. The capabilities and limits of the aural and visual systems inform the structure of the work, guiding the compositional process over time. At each rehearsal during development, new findings are presented and discussed, with new audiovisual correspondences and divergences discovered. In the end, no part of the work is without its partner, and even the improvisational aspects of *Beacon* are executed within a conceptual space which has been explored together. Exploring materiality, both visual and aural, through improvisation within the rehearsal space, helps the performers to elicit new ways of thinking about the audiovisual piece, which in turn shapes the compositional form.

Emerging Framework

By embracing the physicality of the digital performer, utilizing and reinforcing shared temporal and spatial elements of the performance, and allowing the possibilities of distinct sonic and visual systems to guide aesthetic themes and compositional form, a new framework for audiovisual composition begins to emerge. Through the experience of composing and performing *Beacon*, we have encouraged certain elements of collaboration and creativity which we believe to be beneficial to those of us working across media:

- **Expressivity**: Prioritizing human agency and expression in computational practice.
- **Collaboration**: Co-creation of multimedia content from the ground-up.
- **Physicality**: Embracing material limitations as design guidelines.
- **Autonomy**: Freedom to make independent artistic decisions within a tightly-coupled multimodal dynamic.
- **Aesthetics**: A unified trajectory between distinct media which mutually shape an experience.

The next steps include reflecting on this emerging framework by (1) nurturing each section with nitty-gritty examples, and (2) refining the categories so that it can be used by other performers interested in exploring potential relationships between the physical and digital in live audiovisual performance.

Reflections and Future Work

As a piece, *Beacon* is the product of extended experimentation with sonic and visual systems as distinct but related media modes. The work is shaped by the physicality of the human performers and their bodily connections to digital systems, and strives to reinforce and support expressive capabilities of collaborators and harness the physical affordances of either analog or digital interfacing devices. Sharing our explorations in a live performance at TEI will inform our future work toward that end.

These early investigations into a more human-centered way of digital composition raise questions of the role of human and computer in technologically-driven performances, and how the physical manipulation of digital content might shift new media production away from automation and mapping toward a more organic and intimate dynamic. The authors

believe the emerging framework to be a valuable tool for individuals collaborating across media, especially visual and audio, as a way to reconsider the activities of the composer, performer, and digital system in a space of co-creation. It is our hope that further collaborations can be undertaken with increasing emphasis on the emergent features of co-creative audiovisual composition, including the development of new physical instruments, increased emphasis on expressivity and physicality, and an eye toward a unified and robust multi-modal aesthetic.

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