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Computation as Medium

Agency and Motion in Interactive Art

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Abstract

Artists increasingly utilize computational tools to generate art works. Computational approaches to art making open up new ways of thinking about agency in interactive art because they invite participation and allow for unpredictable outcomes. Computational art is closely linked to the participatory turn in visual art, wherein spectators physically participate in visual art works. Unlike purely physical methods of interaction, computer assisted interactivity affords artists and spectators more nuanced control of artistic outcomes. Interactive art brings together human bodies, computer code, and nonliving objects to create emergent art works. Computation is more than just a tool for artists, it is a medium for investigating new aesthetic possibilities for choreography and com-

position. We illustrate this potential through two artistic projects: an improvisational dance performance between a human dancer and a mobile robot, and a virtual reality art work based on procedurally-generated content. Through our practice, we find that computation fosters an interrogative approach to artmaking that raises questions about agency and intentionality, such as how artists work with immaterial processes to generate novel and unexpected aesthetic experiences.

Keywords Art, agency, computation, motion, robotic art, procedural art, virtual reality, choreography

Introduction

Just as the computer transformed human labor practices, so too has it altered artistic practices and media art. The computer has long been a tool for art-making and introduced levels of interactivity that expand the notion of agency in art. For interactive art, the artist is increasingly regarded not as the sole creator of the art work, but rather as a director that devises situations or environments where spectators give life to an art work or event. Interactive art works can be viewed as "scenarios or scores that project the interactive behavior of the receivers" and emphasize "the dynamic of the changeability of an art-work event" (Kluszczynski 2). For interactive art works that utilize computational processes, the question of art's agency is not limited to a discussion of its performative function (Hantelmann) or social function (Gell), but extends to the concept of agency in computer simulations and emergent systems. Interactive art promotes a shared agency where the agency – or intentionality – of an art work is shared between the artist, spectator / participant, and code. Although computational art relies on formal mathematical processes that are deterministic and procedural, computation does not limit the dynamic possibilities for unexpected outcomes but rather expands them by creating art works that are ephemeral and unique. Interactivity and agency are thus linked: the spectator experiences her own agency in the art work as a generator of events.

The article is organized as follows: we briefly outline the concept of agency as it relates to art works and computer agents in interactive art. We then introduce motion algorithms as a method for

interaction that allow the spectator to directly shape the art work. By effecting motion and choreography, the spectator animates the art work – sometimes producing outcomes beyond what the artist had originally intended. The spectator experiences her agency through the perception and experience of motion.

We then describe two art works that we developed in collaboration with research institutions: *The Dynamic Still* (Figure 1) is an improvisational dance performance between a human dancer and a mobile robot, and *Mutator VR: Vortex* (Figure 2) is an interactive, immersive, virtual reality art work based on procedurally-generated content. Both works use motion algorithms to generate organic, natural motion. While on the surface the works appear to be vastly different – an improvisational robot dance performance and a virtual world experienced through a head-mounted display – the strategies of interactivity are remarkably similar. We analyze these works according to the types of agency they afford and articulate how computational approaches to motion can contribute to new artistic experiences.

Figure 1. Sandro Masai performs with a mobile robot in *The Dynamic Still*, an improvisational dance performance at *International Impro Festival* in Aalborg, Denmark. Photo: Barnabás Várszegi.

Figure 2. Participants immersed in the virtual reality art work *Mutator VR* at the *Hybris: Monsters and Hybrids in Contemporary Art* exhibition in Venice, Italy. Photo: William Latham.

Agency

Concepts of agency vary across disciplines and even within disciplines. In art theory, agency can refer to the social agency of art objects (Gell), the performative function of art (Hantelmann), art as a social system (Luhmann), or the conceptual lens of affect and political agency (Massumi). In computer science, the notion of agency is more descriptive as it seeks to designate degrees of autonomy of a given software system and classify agents according to function. Definitions are not exhaustive, but rather meant as a tool for analyzing and evaluating software systems. Franklin and Graesser define an autonomous agent as "a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future" (Franklin and Graesser 1996). There is no unifying taxonomy or classification scheme for software agents, but a variety of approaches. For example, reactive agents respond in real-time to changes in the environment, whereas learning/adaptive agents change their behavior over time based on previous experience.

Such definitions give rise to philosophical considerations: do adaptive agents have more agency than reactive agents? How do agents perceive and understand the role in their environment? These questions are not unlike questions about social agency in art and the humanities. For example, anthropologist Alfred Gell defines social agency as

> a culturally prescribed framework for thinking about causation, when what happens is (in some vague sense) supposed to be intended in advance by some person-agent or thing-agent. Whenever an event is believed to happen because of an 'intention' lodged in the person or thing which initiates the causal sequences, that is an instance of 'agency' (Gell 17).

Gell famously extended the role of social agency from human beings to art objects, positing that nonliving objects can exhibit social agency, for example by causing uncertain or unexpected events to transpire. Unlike Franklin and Greasser, Gell is not interested in classifying agent behavior but rather in theorizing about art's agency

in relational and context-dependent scenarios. He is also careful to distinguish agent-motivated events from chains of physical/material causes, where occurrences or 'happenings' can be explained by physical laws [16]. While the subject of his argument is the static art object, Gell's observations on the link between intentionality and causation – what an agent wants and how it effects change in a given environment – indicate some possible points of connection between agency in art and computer science. For Gell, "an agent is defined as one who has the capacity to initiate causal events in his/her vicinity which cannot be ascribed to the current state of the physical cosmos, but only to a special category of mental states; that is, intentions" (19). While the human psyche is essential to understanding human agency, it does not necessarily prohibit nonliving objects from possessing agency:

> We can accept that the causal chains which are initiated by intentional agents come into being as states of mind, and that they are oriented towards the states of mind of social 'others' […] – but unless there is some kind of physical mediation, which always does exploit the manifold causal properties of the ambient physical world (the environment, the human body, etc.) agent and patient will not interact. Therefore, 'things' with their thingly causal properties are as essential to the exercise of agency as states of mind. In fact, it is only because the *causal milieu* in the vicinity of an agent assumes a certain configuration, from which an intention may be abducted, that we recognize the presence of another agent. We recognize agency, *ex post facto*, in the anomalous configuration of the causal milieu – but we cannot detect it in advance, that is, we cannot tell that someone is an agent before they *act as an agent*, before they disturb the causal milieu in such a way as can only be attributed to their agency (Gell 19).

Gell's focus on intentionality and environment correlates with Franklin's autonomous agent that acts "in pursuit of its own agenda" and senses and acts on its environment over time (causal milieu). While computer science and philosophical concepts of agency are far from synonymous, they are both concerned with

human or nonliving agents that interact meaningfully with and relate to their environment. Thus, agency might be understood as "a glob- al characteristic of the world of people and things in which we live, rather than as an attribute of the human psyche" (Gell 20). For inter- active art, where the spectator is invited to interact with art works that use reactive software agents or autonomous robots, agency can be experienced through movement and embodiment.

One aspect of computational art is the ability to generate organic-like motion from a combination of inorganic materials and immaterial processes. Motion algorithms that are encoded in software are fundamental to how interactive art works are generated, and therefore it is a useful starting point for examining agency for interactive art. Our primary interest is how abstract conceptualizations and reasoning about motion are made explicit through computation, and how movement and choreography influence the spectator's experience of agency in an art work.

Motion

We can conceive of two types of motion for interactive art – physical motion generated by the spectator and computer motion generated by algorithms. For interaction to take place, the spectator must be able to use their body to effect some meaningful or observable change in the computer motion. An interface such as a mouse, a handheld controller, or a tracking device captures the spectator's physical gestures that can then be used to influence – but not dictate – the motion of a virtual agent or robot. Independent of the interface, the spectator experiences a sense of shared agency as she observes the effect that her behavior (input) has on an autonomous agent and the effect on the resulting art work (output). The experience of this active feedback loop between spectator and computer program, observable through motion, is a simple illustration of how interactivity affects the experience of agency.

Interactive art utilizes immaterial processes – coding, sensing, and computation – that invite the spectator into an interaction with the art object/environment. The invitation to act was a key factor in the participatory turn in visual art, evidenced by Fluxus artists and others such as Robert Morris, Trisha Brown, Simone Forti and Yvonne Rainer, who transformed the role of museum goers by giving spectators the chance to participate in art works with their

whole body. In these works, the environment was a key factor for cultivating the experience and awareness of agency. The defining feature of participatory works is their unrepeatability predicated on chance, individual experience, and direct participation. While the computer may not radically alter this expanded notion of agency, it does afford unique possibilities that give artists and spectators more opportunities for nuanced interaction. For example, artists can define specific rules that guide the spectator towards specific gestures or exchanges that enable them to produce singular experiences. Leveraging the power of computation, artists can place certain constraints on interactions (for example, limiting the types of affordances available to the spectator) that result in novel experiences. Spectators "exploit the manifold causal properties of the ambient physical world" designed by the artist, and experience a nuanced sense of agency. When a spectator interacts with an art work using motion algorithms, the experience of agency is tied to the transformation of bodies in motion – the human body triggering, controlling, or eliciting some perceived motion or transformation in the art work.

Computation provides artists with a formal language for describing and representing motion, but the embodied experience of motion and agency is shaped by the interface and the structure of the art work. As artistic researchers, we are deeply interested in leveraging the potential of computation to create new aesthetic experiences that promote interactivity and augment the spectator's experience of agency. Working with different materials (embodied robots and virtual reality), we share similar approaches to designing motion and interaction.

The Dynamic Still

The Dynamic Still[1] is an ongoing research experiment into improvisation and choreography for humans and robots. The goal is twofold: to develop improvisation sketches for performance between a robot and human dancer based on real-time interactions, and to design motion algorithms that support human-robot interaction. The mobile robot is a four-wheeled cart that moves in response to input from the dancer. None of the choreography is preprogrammed, and we deliberately refrain from teleoperating any movements during the performance. We experimented in an open

studio setting, exploring mapping different motion algorithms to the robot based on movement patterns of the human dancer. We established an improvisation sketch where dancers from three distinct dance traditions (physical theatre, modern dance and break dancing) generated a 7-10 minute-long performance together with the robot. There is no set time signature, so each improvisation evolves according to the individual dancer's pace.

We were inspired by interactive art works that merge dance and sculpture – particularly Robert Morris' "task-oriented" performances that investigate the aesthetic potential of ordinary movement and William Forsythe's "choreographic objects"– sculptural installations which prompt spectators to interact with material objects designed to materialize choreographic thinking. We were also inspired by Louis-Philippe Demers' *The Tiller Girls* (Demers 2016), a live dance performance comprised of thirty-two small, autonomous robots that experiment with synchronized motion and various walking gaits for low-degree of freedom robots. A public performance featuring dancers and live musicians was staged at the *International Impro Festival* at Aalborg Theatre in Denmark in March 2017.[2]

The Dynamic Still began as an investigation of improvisation: what does it mean for robots to improvise? Improvisation is an important aspect of human performance, and essential to the experience of liveness in performance. When robots appear onstage, their performances often appear mechanical and perfunctory (Jochum et al. 2014). While this is obviously a function of robot design, we suspected it might also relate to the algorithms that determine robot motion. We wondered whether improvisation might be a useful method for designing robot motion, and questioned how interaction with a robot might inform new ways of moving for dancers. While the work culminated in a public performance, we view the project as an experiment in adapting process-oriented approaches to choreography. We used a "bottom-up" approach, and began by exploring the most basic patterns of movement and mimetic behaviors to generate simple motion commands based on input from the participant.

The decision to work with a mobile robot presented certain advantages and limitations. The non-anthropomorphic platform avoided that the robot might be interpreted as a metaphorical

human. The non-human form also prompted the dancers to interact with the robot according to spatial awareness and orientation, rather than representational gestures. However, the range of movement available to the robot is limited: the robot can only move horizontally (although in several directions), tracing a path along the floor and varying its speed. Limited to proxemic movement and lacking the capability for expressive, gestural movement, the robot had only a small number of behaviors: following, mirroring, repeating, and circling the dancer. Despite these limitations, a wide range of interesting spatial arrangements and coordinated action between the dancer and the robot emerged. Stillness also because an important action: alternating moments of stillness created poetic moments where even the dancer was momentarily uncertain about who was following and leading. We are analyzing the video documentation of each improvisation to understand how motion algorithms can be adapted to develop more creative and unexpected choreographies. Eventually we will develop learning algorithms that enable the robot to learn from the dancer's input and become a more capable improvisation partner. Our initial findings suggest that dynamic and aesthetically interesting choreographies can emerge even with limited motion. Although the motion algorithms were identical, the individual dancers elicited unique behaviors and unexpected motions using the same interaction paradigm.

Mutator VR

Mutator VR takes the abstract organic forms of *Mutator* (Todd and Latham 1992) into a new type of sensing space through virtual reality. Virtual reality offers a rich kind of immersion and trackingbased interactivity that can provide an enhanced sense of presence by creating an intimate bond between spectator and virtual object. The work consists of two unique experiences, *Mutation Space* and *Vortex*, that explore different uses of virtual reality to enhance the viewer's participation and interaction with the artwork. In *Mutation Space*, the viewer manipulates a complex, procedurally-generated form through various inputs from a pair of handheld controllers. The participant can make gestures to change the shape of the form or modify various aspects of the environment, such as lighting. The biological form emits sound that reflects changes in its shape and position. *Vortex* immerses the spectator into parallel

fantastical worlds inhabited by alien lifeforms and evokes an experience not unlike scuba diving. Using handheld controllers, the participant can attract and repel creatures with force fields to choreograph their motions into complex flocking and swirling patterns. Each creature sounds with a unique "voice" that is spatialized to create an emergent, unique spatial soundscape. The participant can smoothly morph between worlds with a controller press to experience a new environment with a unique set of creatures, interactions, dynamics, and sounds.

Figure 3. In-VR screenshots of *Mutator VR: Vortex*. The coil shapes near the bottom of the screen represent the controllers held by the participants, which are used to create force fields to interact with the autonomous agents.

One interesting aspect of *Mutator VR: Vortex* is how convincing both the autonomy and social interactions of the creatures appear, given that their dynamics derive only from a basic particle system

driven by vector flow fields and Newtonian laws of motion (Reynolds, 1999). In exhibition surveys, many participants reported positive feedback with regards to the level of immersion, interactions with creatures, and perhaps most importantly, the feeling that they were in another world (Putnam, Latham, and Todd). To give participants a strong sense of presence or "being there" in the world, we paid careful attention to providing "environmental presence" through a sufficient level of agent autonomy and obvious cause-and-effect user interactions (Slater et al., 1994) (Heeter, 1992). These interactive elements contribute to the spectator's experience of agency: without them the participant would have a diminished sense of presence in the generated worlds, as there are no perceivable consequences to their actions. The spectators perceive their impact on the environment, or as Gell calls it, their *casual milieu*. By supplying both virtual creatures and humans with some degree of agency to act on the virtual world and interact with each other, the participants gain a more coherent (Slater et al., 1994) and complete sense of participation with the art work.

Interaction-Driven Agency

The artistic research projects presented here only begin to touch on the myriad possibilities for exploring motion using computational tools. Both *Mutator VR* and *The Dynamic Still* use motion algorithms to generate unique art works that utilize computational motion and rely on interactivity to complete them. While there is much that divides these two works – different genres of dance and audiovisual art, real-world environments versus virtual reality – both works are predicated on strategies for nuanced interaction built around a grammar of motion. Through interaction with an interface, the spectator is transformed into a co-creator of the art work. Whether the spectator is a trained dancer or a member of the general public, the principles of interaction model a similar type of agency, where input is translated by the computer code into a meaningful output that generates the motions of a nonliving object. Operating on Gell's two propositions that 1) agency cannot be detected in advance but only becomes evident when the agent acts as an agent, and 2) agency relates to the configuration of the causal milieu and agent's effects on the environment, we realize how computational strategies might augment the experience of agency for in a work of art.

Computer code offers artists a formal method for describing the entire spectrum of motions and the means to generate motion, from deterministic to chaotic or chance-based rules. Whereas early computational art was dominated by questions about what the computer could do, artists now think more systematically about the opportunities afforded by computation. The experience of agency in interactive art need not be limited to the artist or spectator alone, but can be conceived as a dynamic field of relations.

Computation involves the transformation of material and also transforms how art works are conceived, generated, and experienced. Generative approaches to movement open up new avenues for improvisation and exploration for artist and spectator, presenting opportunities for interaction-driven motion and agency. These interactive art works bring together human bodies, computer code, and non-living objects where the dynamics of interaction create an emergent art work. Computation is more than just a tool, it is a medium for exploring new aesthetic approaches for choreography and composition.

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Notes

1 The title is inspired by Mary Bryden's article "Beckett and the Dynamic Still" (Bryden 2004). Bryden's insight inspired us to consider the relationships between motion, stillness and character with aspects of visual and performing arts.

2 Video recording of the performances are available at https://vimeo.com/211666686