Research in Brief

Sensory, Sonic, and Symbolic Features of a Collaborative Media Art Practice

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ABSTRACT  The “Lo-fi” project applies iterative and prototype-based processes to a collaborative media art practice. The project has entailed several modes of experimentation: electronics, sound, programming, interactivity, iterative design and evaluation. The prototypes and interactive artworks that have been built through the project are treated not only as works for exhibition but also as objects of study, examinable both in terms of empirical research outcomes and in terms of their symbolic import for viewers and interactants. We discuss a methodology for gathering data in a gallery context, based on the inaugural exhibition of the first Lo-fi artwork, Push/Pull (2009).

KEYWORDS  Collaborative research; Media art; Human-computer interaction; Embodiment

RÉSUMÉ  Le Projet « lo-fi » applique des processus itératifs basés sur des prototypes à une pratique collaborative dans les arts médiatiques. Le projet a entraîné plusieurs modes d'expérimentation : son, électronique, programmation, interactivité, ainsi que design et évaluation itératifs. Les œuvres d’art interactives et les prototypes créés pour ce projet existent non seulement pour être exposés mais aussi pour être étudiés, tant dans le contexte de recherches empiriques que dans celui de leur importance symbolique pour observateurs et participants. Nous présentons en outre une méthode pour recueillir des données dans une galerie d’art en nous fondant sur l’exposition inaugurale de la première œuvre d’art « lo-fi », Push/Pull (2009).

MOTS CLÉS  Recherche collaborative; Arts médiatiques; Interaction humain/ordinateur; Incarnation

In our collaborative media art practice, we have built both prototypes and interactive artwork for exhibition, as well as engaging in “evaluation” in the fields of both human-computer interaction (HCI) and contemporary interactive art. Bridging our very different backgrounds as Computer Science researcher and New Media artist, we have identified the common research goal of rendering and studying complex cognitive and physical interactions between human and non-human agents who coordinate behaviours (see also Sawchuk, 2008).

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We focus here on the iterative design process that resulted in our first collaborative interactive artwork, Push/Pull (2009), which started from the notion of representing populations of artificial agents using pared-down means, (i.e., depictions using clusters of light moving across the display surfaces of the artwork and electroacoustic sounds). We describe the advantages in our collaborative approach, outline anticipated and unanticipated features of Push/Pull and analyze some viewer responses to the artwork. These were gleaned over a two-day period in December 2010 during its first public exhibition, in thelivingeffect. 1 We interviewed approximately a dozen people as they exited from their interaction with Push/Pull, with the aim of conducting evaluations and user studies. We composed interview questions in collaboration with Dr. Kim Sawchuk, who has worked with the Lo-fi project team since 2006. This embracing of the empirical in an art setting has created opportunities; for example, it has enabled us to see the display of art within the conventions of the gallery context in a new light. It has also posed challenges: the data gathered showed a wide spectrum of responses to the artwork and defies easy analysis.

**Collaborating across paradigms**

Within the context of the iterative and prototype-based process of building Push/Pull, we now find that we have conjoined the meaning of “abstraction” from two intellectual paradigms: Art/Media Studies and Computer Science. In art parlance, the configuration of sound and light in our work is abstract because of its selective elimination of specific levels of detail, breaking its clear referent associations: a cluster of LED lights is used both to embody artificial agents and to embody human-representative agents. Abstraction, in the software design sense, is invoked in the use of a single computational agent architecture to instantiate agents of two different types: either as endogenous (initiative and behaviours are triggered autonomously within the agent itself, each running on its own particular computational thread) or exogenous (behaviours run by an interactant). A single agent is represented by a particular electroacoustic sound and cluster of lights, with one colour for agents that represent humans and another for artificial agents that are completely controlled by the system. Other light phenomena appear in the same physical infrastructure, and the sounds are sampled from real-world sources and intensively processed using digital effects. We have coined the term “low-fidelity embodiment” for this abstract representational strategy and use the rubric “Lo-fi” to describe the project as a whole.

For Push/Pull, we also experimented with various levels of abstraction in the interface. The artwork is circular in shape, approximately five feet in diameter. Light displays are created on the uneven topography of its surface via arrays of optical cables that are connected to individual LEDs, mounted on circuit boards (see Figure 1). Two small cameras mounted above the sculpture and a ring of infrared LEDs around its top edge allow the cameras to track interactants as they circle around the sculpture in a darkened space. Four speakers are placed about eight feet away from the sculpture. The interactant negotiates the physical space around the sculpture; through movement, the interactant is “tagged” by the cameras by passing through “sweet spots” in the space around the sculpture, so that he or she can move a cluster of lights that is visible on the surface of the sculpture. Being tagged also launches a short video that
essentially demonstrates the movement required to operate the work. This is another sense of the work’s abstraction; all of the features of Push/Pull point back to itself and its placement in a space in a highly self-referential mode.

One of the primary goals in designing Push/Pull’s interface was to elicit conversation that includes the interactant (i.e., “conversation” in the basic sense of the term, as a free exchange of turns). In doing so, the key challenge was to abstract away detail, but to leave certain core, salient features of classical interface design in place, specifically mapping functions. The mapping function pertains to the yoking together of an interactant’s movement (moving forward/backward corresponds to the cluster of lights moving up or down, and moving left/right corresponds to its left/right movement) and his/her agent’s movement through the abstracted Cartesian space of the agent world. The mapping function is discovered by the interactant, who engages in a process of iteratively refining his or her conceptual model of the artwork as he/she interacts with it.

Donald Norman’s (1988) Human Action Cycle is predicated on the observation that humans are “explanatory creatures” and seek to build conceptual models of the objects with which they engage. We anticipated that the Human Action Cycle would be useful as a descriptive model for certain facets of an interactant’s understanding of the piece. In particular, we observed consistent evidence of the execute/evaluate cycle that Norman (1988) postulated, as the interactant adjusts her or his movements in order to derive a conceptual model of the state transitions and behaviours of the system (the term “system” here views Push/Pull as an assemblage of parts, including its programming and visual/aural outputs, that operates as a whole; state transitions refer to changes in the system’s configuration over time). Once the mapping function is discovered, the interactant has acquired a mode of “communication” between his/her embodied agent and the artificial agents; the mapping function mediates the conversation, since it affords a turn-taking among the agent population, human-representative in-
cluded. The type of conversational exchanges that can be jointly performed consist of sequences of one or more greet-response pairings. A cue to the interactant to initiate this “conversation” is provided in the form of a video that is displayed on a small LCD screen embedded in the sculpture, that shows two abstracted figures conversing and moving in a way that mimics the movement required to activate the agent population.

**Collaboratively designing and building interactive artworks**

The collaborative spirit of Lo-fi permitted experimentation with custom LED circuit boards, acoustic representation of agents, novel physical structure, and collaborative methods for programming and evaluation. The *Push/Pull* artwork exemplifies each of these areas.

Baljko and media artist Nick Stedman developed the communication protocol to be used between the computing platform and the LED-controlling circuit boards so that software (MaxMSP and Java) could control the LED light levels. The lights visible on the surface of *Push/Pull* are wired to custom LED boards via fiber optic cable. The design and fabrication of the boards, carried out by Stedman, was in some ways an engineering design task since the communication protocol needed to be as fast and efficient as possible; however, the efficiency of the protocol depended on the nature of byte packet traffic (the information) taking place between the computational platform and the circuit boards. This cannot be known entirely in advance, since it is determined by the overall size and complexity of the agent embodiments on the display and the complexity and refresh rate of their behaviours. Our solution was for *Push/Pull* was to employ a protocol that uses individual LED indexing.2

The Lo-fi project also required electroacoustic processing, which was carried out by sound artist John Kamevaar, and was a particularly good fit for the project because the process retains a vestige of the sound sources, but is barely representational. The project required a cumulative sense of involvement for the interactant, as the interactant moves around the sculpture. Kamevaar developed a soundscape for the first phase of the interaction, whereby sounds are triggered by the interactant before the sculpture is “unlocked” and begins to lead the interactant through its routines. These sounds, such as walking on various surfaces, are just discernible and serve to focus the interactant on understanding the active space of the work. A pulse in sound provides the cue that signals the unlocking of the full interaction, at which point the agents are either distinct and singular voices, or a chorus of voices (the latter occurs when the interaction is vigorous and a whole population of artificial agents is conversing among themselves and with the human-representative agent). Kamevaar responded to the conversational mode for co-agency in the interaction by leaving a clear sense of human voice in the human-representative agents’ sounds—there are two of these sounds, assigned to different agent shapes. The digitally-processed sounds generated for *Push/Pull* are aural behaviours that strongly contribute to the characterization of both the system and the agents as co-constructors of the experience, with the human interactant.

The collaboration on the *Push/Pull* project brought together students and faculty from both the fields of Media Arts and Computer Science. A number of students, both graduate and undergraduate, collaborated on the project6; Tenhaaf led the physical
design and building of the *Push/Pull* sculpture, which is modular (in four panels that form a circle) and shows the LED cluster agent population on any of those panels at different times, depending on the interactant or group of interactants’ movements; while Baljko led the software architecture design for the agents, as well as the integration of the agents with the circuit boards (via the communication protocols) and with the other software components. Several programming languages and software toolkits were used, including Java and RXTX (Baljko), as well as MaxMSP and Open Sound Control (Tenhaaf).

Lo-fi is a highly iterative project with various outcomes. The iterative approach means that we incorporated the findings from mounting prototypes into further development, weighing and considering feedback gathered primarily through interviews and observation, both *in situ* and on the basis of collected video data. Dr. Sawchuk has designed user experience protocols and carried out interviews with us on a number of occasions prior to the Ottawa Art Gallery exhibition: twice at the Ontario Science Centre in Toronto, Canada in 2007 (May and July), and twice also on York University campus: March12-14, 2008 in a public space in the Technology Enhanced Learning building, and in August, 2009 in a studio space in the Goldfarb Centre for Fine Arts. The first prototype testing for a tracking system was at York in a project room in the Accolade West Building in May 2006.

**Symbolic features intended in the design of Push/Pull**

In developing the Lo-fi artworks, the research on Artificial Life (A-Life) and the host of A-Life artworks that have appeared internationally over the past several decades were highly instructive (Tenhaaf, 2008), including artists’ robots and electronic displays that may adapt and evolve over time, as well as hybrid software and physical systems that can include living parts. In developing the Lo-fi artworks, we have looked to aspects of A-Life research in which the emphasis has been moved away from the building and the studying of the A-Life artifact itself, and toward the exploration of a social environment in which such artifacts are deployed. Thus, the manifest behaviour in our work depends on the behaviours and choices made by the human interactant(s) in a conversational exchange involving the community as a whole. Consideration of this social environment also required consideration of what the interactants would bring from their experiences with other software interfaces, including everyday interfaces and even those used in gaming, in particular when the latter involves whole body movement.

Social relations among interactant(s) and sculpture are established through a chain of events. First, the human interactant needs to imbue the system, via the sculpture’s interface, with certain characteristics or properties in order to treat it as a co-interactant. We conceptualized this as a process whereby the interactant makes presuppositions about the degree of the system’s agency. This can be rationalized in part by prior research, which amply demonstrates that humans readily apply social rules, even when interacting with computational media (and even when they *know* the media is computational), and that computational agents are anthropomorphized by human interactants (Reeves & Nash, 1996). The anthropomorphizing urge is very strong, and there was no evidence that interactants with this piece were any exception.
Push/Pull shows the degree to which a conventional interface can “disappear” (or the manifestation of the interface be subverted by offering very little in the way of instruction) and still elicit a strong response of anthropomorphization. In line with the abstraction strategies at the heart of Lo-fi discussed above, the un-conventional, minimalist interface that allows us to explore, among other things, the progression from “novice” to “expert” user of the system remains of particular interest.

Within the abstract arrays of lights and sound, both the sculpture itself and the light cluster agents may be anthropomorphized and assigned agency; however, the anthropomorphization of the light clusters relies in part on the mapping of the interactant to their representative agent, and this requires very active and purposeful movement that not every visitor is willing to make. It also relies on the interactant’s conceptual model that recognizes his/her representative agent’s behaviours within a population of other agents. Further, on another level of conceptual abstraction, Push/Pull has strong qualities of self-reflexiveness (as opposed to narrative associations), such that it foregrounds its qualities as an interface and seems to be about interactive technology itself; it is consequently interpreted by interactants as a system with some kind of “intelligence” that appears to be setting the terms for the interaction through its own logic and purpose, even though those terms are not overtly cued. The current state of the piece is signaled through highly abstract means: there are different views of the same agent population at its four different panels and the interactant’s window into the state of the whole system depends on which of the panels she or he is looking at. The shift in granularity from this agency invested in the whole object, to the agency of LED clusters displayed within the object, requires a non-intuitive cognitive shift.

Features of the work that followed (unpredictably) from its design

Performativity
As an art object, Push/Pull reminded one interviewee (an art historian) of László Moholy-Nagy’s Light-Space-Modulator of 1930, a kinetic sculpture that he built to design displays of light and movement, and a piece that was intended to be used in dance and theatre performances. This highly abstract work is an example of the link between abstraction and event (rather than between abstraction and image) in the history of art, which has both historical and contemporary resonance for media artists. For example, the canvas for Abstract Expressionism is an arena for action as much as a space, as exemplified in Action Painting. Chris Salter (2010) ties abstraction to the performative qualities of media artworks, through Futurist and Constructivist experimental theatre and beyond, to immersive qualities in works such as the large-scale projections of Granular Synthesis.5

A meeting of the spheres of art and Human-Computer Interaction (HCI) research occurs in Lo-fi in the arena of performativity. Many of the same HCI design challenges that apply to an interface for an everyday technology also apply to an interactive artwork. In both cases, the user is invited to engage with, or perform with, an artifact. The user must first of all be transformed into a participant, and secondly, must be guided in the co-construction of meaning in a back-and-forth with the artifact. A fur-
ther parallel between interface design and art lies in the principle that perception plays a performative role. Dalsgaard and Koefoed Hansen (2008) argue that it is the awareness of a spectator, or even the potentiality of one, that transforms a user into a performer. A first-order relationship with the sculpture is easily established by interactants through their movement around it. If a spectator is present, this can establish a second-order relationship with the work because the spectator’s experience is mediated by their observations of another person. In a further variation, an interactant may change his/her behaviour when aware of being in the role of performer. Push/Pull allows for multiple interactants, and so an ambiguity among roles of interactant and spectator can arise. We are currently exploring ways other than exhibition settings to reveal Push/Pull’s amalgam of behaviours more thoroughly to the public; for example, performed by an interactant for an audience.

Co-construction of experience in interacting with Push/Pull requires a recognition that the work itself is a performer, a parallel to the interactant’s understanding of “intelligence” in the work, described above. This sets out a commonality of experience among interactants. At the same time, however, the process of interaction is highly individualized and the interactant’s experience counts, whatever it is and no matter what feedback the system gives. Indeed, there is no “right” way of interacting; yet, interactions built into Push/Pull are potentially frustrating (to both designers and users) if the cues for eliciting them are not perceived. For example, one of the panels reveals a population that grows from two to six artificial agents, but only provided that the interactant first succeeds in performing two greet-response interactions with the artificial agents that are initially shown. This is the most game-like moment of Push/Pull, although its rules of game-play are not overt and instead must be discovered through the interaction. The execute/evaluate cycle from HCI, mentioned above, was particularly apt for describing this component of the artwork’s interactivity. Our user interviews have shown that the composite of Push/Pull’s repertoire of behaviours with the interactant’s performance is clearer to some interactants than to others.

Immersion

Two senses of “getting lost” converge in Push/Pull. One is the sensation, highly appealing for some people, of losing themselves in an experience. The other is a confusion of not knowing one’s way, or knowing whether one is “getting” the (presumably) “gettable” which is, as Norman (1988) posited, a way of thinking and developing expectations that is quite pervasive. The latter sense is exploited in the recent “gamification” of everyday interaction to entice people to participate, offering rewards for levels of achievement. Along with its game-like mode, Push/Pull also allows a more experiential mode of interaction, which lends itself to the first sense of getting lost, which is a sense of immersion. The very low light level in the installation of Push/Pull for some contributed to a sense of immersion, whereas for others served to push them away, even to the extent of quickly aborting the interaction. Some members of the public expressed their fear of entering the dark space, their concerns about bumping into something and causing damage, or simply found it unpleasant to be in the dark for the period of time that it required for their eyes to accommodate to the low light.
Praxigrams
From the interview process during the course of the exhibition thelivingeffect, it became clear that there was a great degree of heterogeneity in the interactants’ experiences with the work. A core premise is that once agency has been attributed during the interaction, it is not merely an information exchange but a communicative process. Because movement establishes the mapping function, and thus recognition of agents, anthropomorphization, and conversational turn-taking as features of Push/Pull, it would seem that a key indicator of variation in experience would be proxemics, or how one uses physical space in a communicative process.

Our desire to probe the proxemics of the varied interactions with Push/Pull motivated the development of what we call praxigrams, which is a visualization format that characterizes the interactant’s movement around and toward the artwork as if viewed from directly above. In principle, proxemic data could be identified and extracted computationally from a video stream from an overhead camera (the challenges from low-light conditions, tracking multiple interactants, and data processing demands notwithstanding). Instead, we elected to videotape the interactants using two cameras positioned at different angles, and then transcribe the proxemics from the video afterward. To derive the praxigram itself, we implemented a customized software interface whereby a transcriber can use mouse movements to trace out the interactant’s movements as observed in the video. In the case of multiple interactants, the transcription process was repeated for each interactant. Both camera angles were consulted to interpret the interactant’s movements as they would appear from a hypothesized bird’s eye perspective. This included direction and speed of motion relative to the sculpture, as well as time spent at any of the sculpture’s panels. We also recorded Tenhaaf, a very experienced interactant, interacting with the sculpture and generated a corresponding praxigram to create a basis for comparisons (see Figure 2).

The behaviour of the videotaped interactants was possibly affected by a number of factors; namely, the need to secure prior informed consent from the participants, and the physical presence of the data collection equipment (and the human operators). An interactant who has the sense of being observed may behave differently than if unobserved. The cameras themselves were visible to the interactants (and the LED indicator of the camera was mistakenly understood as being part of the artwork by one interactant). It proved impractical to leave the cameras running during all exhibition hours, which meant the cameras needed to be activated and deactivated manually.

We have coordinated the praxigram data of two sets of interactants with their respective interviews: one a solo interactant (S) [see Figure 3], and the other a pair of interactants (P1/P2), (see Figures 4 and 5). Each of these three interactants self-identified as experienced and knowledgeable viewers of art exhibitions. P1 and P2 reported a strong sense of immersion in their interactions, whereas S did not. P1 and P2 each reported that they forgot about interacting per se, so that a feeling of immersion would predominate. For example, P1 felt that he/she was “listening to and observing [him/her]self,” more than being consciously aware of interacting. P2 described how he/she repeatedly stopped to take in the sculpture’s behaviours, and then had to “re-
member that there’s an interaction so I have to move.” S was very concerned with figuring out what to do, reporting that she asked “am I making it work?” during the interaction and that she “wasn’t even sure I was supposed to circle around it.” S felt that the piece was not explicit: “people aren’t going to get it.”

The P1/P2 interview, correlated with their praxigrams, showed that there was something to be achieved from interacting with Push/Pull even without the overt, direct “readable” response from the system that many interactants expected and needed. Interestingly, the greatest contrast among these praxigrams was between the group of P1/P2 and Tenhaaf, and the S praxigram.
Conclusion
Low-fidelity embodiment has been a productive concept at the core of the Lo-fi project, both for making artwork and for the collaborative process with its core focus on bridging conceptual and terminology gaps between the fields of Computer Science and Media Arts. We have used it as a bridge between the research literatures from Human-Computer Interaction and art/media studies. It has been very effective as a representational strategy and a template for the design of interactive behaviours. Low-fidelity embodiment for agent representation has a level of abstraction that allows for subtle shifts in an interactant’s perceptions, from artificial entities to other manifestations of light (such as the video imagery) and other computational imagery (such as the cellular automaton that we used to close one phase of the interaction in Push/Pull).

The long, collaborative, research-based process for making art is very different from the more familiar process of materializing a concept and resulted in the interactive work Push/Pull converging to a state that it would not have otherwise. It is a multi-layered artwork that is much appreciated by viewers as both an aesthetically appealing and intriguing object. It is also a challenging work for the art public. Our user interviews and videos show a wide range of experiences: at one end of the spectrum are gallery-goers who have a very immersive and body-based experience with the work and who also are not concerned about whether they are “correctly” performing the work’s interactivity; at the other end are people who, throughout their engagement with the piece, wonder whether they are “getting” either its routines or its symbolic import, to the extent that the spontaneity of their actions is undermined.

Push/Pull is a shaper of behaviours. Whether it is best experienced as first-order (as an interactant) or second-order (as a spectator of the interaction) depends very much on the individual. Our research outcomes related to prototyping, exhibiting, and evaluating Push/Pull have given us some insight into how different viewers navigate a subtle interface that opens up highly abstract content. These different modes of navigation, and one might say their success, are directly related to viewers’ appreciation of the symbolic or aesthetic merits of the work. This kind of study is new in a gallery setting and can contribute to a broader study of the impact of new media artworks.

Notes
1. thelivingeffect group exhibition was curated by Caroline Langill and held at the Ottawa Art Gallery in Ottawa, Canada between November 2010 and February 2011. The title refers to artist Norman White’s quest to capture in his work the subtle energies and forces inside every living creature.
2. Stedman and Baljko examined the tradeoffs of vector-based v.s. individual-indexed approaches to signaling LED light levels. They identified the tipping point of the optimality from the first approach to the second, in terms of total number of LED changes per frame. Each approach has its merits.
3. See the Lo-Fi website. Our thanks to all of the students who participated in the project: Eng Chuen Chuah, Zev Farber, David Jacob, Michael Kaftarian, Heather Phillips, Miki Rubin, Niknaz Tavakolian, and Dustin Wenzel.
4. See also the Fundación Telefónica website.
5. Granular Synthesis is a renowned audio and video performance project of Austrian artists Kurt Hentschläger and Ulf Langheinrich.
6. The researcher’s immersion into the research field is known to affect results, see Davies (1999).
Websites
Lo-Fi. www.lo-fi.ca

References