
Moving on its Own: How do Audience Interacts with an Autonomous Moving Artwork

Florent Levillain

Laboratoire CHART-LUTIN
EA 4004
Université Paris 8
2 rue de la Liberté, 93526
Saint Denis – Cedex 02
FRANCE
flevillain@mac.com

Elisabetta Zibetti

Laboratoire CHART-LUTIN
EA 4004 Université Paris 8
2 rue de la liberté, 93526
Saint Denis - Cedex 02
FRANCE
ezibetti@univ-paris8.fr

Sébastien Lefort

Sorbonne Universités
UPMC Univ Paris 06
CNRS, UMR 7606, LIP6, F-
75005 Paris, FRANCE
sebastien.lefort@lip6.fr

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
CHI'15 Extended Abstracts, April 18–23, 2015, Seoul, Republic of Korea.
Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3146-3/15/04...\$15.00.
<http://dx.doi.org/10.1145/2702613.2702973>

Abstract

In contemporary art, a new type of artworks use motion as a material from which to create the illusion of life. These autonomous robotic artworks have a behavioral specificity; they tend to be perceived as living, and by some account intentional entities. To account for this behavioral specificity and how it affects the audience experience, we propose a data-driven approach to reveal specific visit patterns. Through a cluster analysis performed on visitors' path inside an installation involving autonomous objects, we highlight four different attitudes characterized by patterns of approach or withdrawal, passive observation and exploration.

Author Keywords

audience experience; interactive arts; behavioral artworks; engagement; cluster analysis

ACM Classification Keywords

I.2.9 [Artificial Intelligence]: Robotics---Autonomous vehicles; J.4 [Social and Behavioral Sciences]: Psychology; J.5 [Arts and Humanities]: Performing arts

Introduction

Take a mental snapshot of a museum or an art gallery, what do you see inside this picture? Objects most probably, pictures, sculptures or installations, objects captive to your glance, objects here for you to admire, to walk around, to contemplate, quietly waiting for you to be revealed as works of art. But imagine that one of these objects now suddenly starts moving on its own, wanders in the room, takes a glimpse, maybe even at you. Who is the observer now? This situation is not unusual in contemporary art. Take for instance Jeppe Hein's 360° Presence (2002), a large ball of steel that moves randomly inside a room, progressively ravaging the walls as it keeps banging into them. While extremely simple, this artwork takes a life of its own, it seems to move on purpose and can be described using psychological attributes (aggressive, stubborn, erratic, etc.). There is a tradition of autonomous objects in art. Robert Breer's majestic Floats (1970), the animal robot by Edward Ihnatowicz (The Senster, 1970), Jean Tinguely's immense self-destructive mechanism, Homage to New York (1960) are examples of artworks that have in common to use motion as a material from which to create the illusion of life [1].

Autonomous robotic objects in art are part of a larger trend involving the design of interactive computational systems that evolve in real-time, capturing certain aspects of the audience behavior and adjusting their output accordingly. These systems have been categorized by [2] as either *dynamic-passive* (objects that change spontaneously or are modified by an environmental factor), *dynamic-interactive* (with the possibility to react to the audience), and *dynamic-interactive (varying)* (with the conditions of interaction changing as well). Autonomous robotic objects may be

considered either dynamic-passive or dynamic-interactive depending on whether they adjust or not to the audience. However, their specificity lies in the fact that they tend to suggest a genuine behavior to a human observer. The ball of steel previously described is dynamic as it moves spontaneously, but what is striking about it is its sense of aliveness, and the impression that it acts purposefully. This 'behavioral' specificity is something more than the mere autonomy as it depends both on the motion cues produced by the object and on the interpretative skills of the observer. For this reason we will now refer to the previously described autonomous objects in art as "behavioral artworks". In essence, behavioral artworks are objects that, because of the way they move, elicit a perception of animacy, animacy perception being the perception and categorization of an entity as a living, and by some account intentional being [3].

Audience experience with behavioral artworks

A large amount of literature has been devoted to the interaction with computer-controlled interactive artworks [4, 5, 6, 7]. As experience is a key issue in interactive art [8], HCI researchers try to define how people engage into the specific interaction modalities proposed by an artwork and how the interaction is sustained over time [9].

The way an audience interacts with a behavioral artwork is likely to depend on the psychological properties attributed to this object. The fact to perceive a robotic object as having goals or intentions may give rise to feelings of sympathy, empathy, or uneasiness and fear if its behavior is interpreted as aggressive [10]. In turn, these psychological attributions may yield



Figure 1. Three pianos moving on their own.

a tendency to approach or to keep a distance from the artwork.

Specifying the interaction modalities with a behavioral artwork would require to better understand how visitors interpret its behavioral properties, and to evaluate systematically the interaction patterns that emerge at the contact of such an artwork. In this study we undertake the latter goal, by examining the relation with a behavioral artwork through the recordings of visitors' tour inside an installation involving several autonomous objects. With a data-driven approach grounded in the observation of visitors' displacements, we look for visit patterns that could reveal different ways of engaging and interacting with a behavioral artwork.

The present study

In this article, we examine the recent installation *Off Road* (2013), created by Céleste Boursier-Mougenot at *Les Abattoirs*, Toulouse, France during the 2014 summertime. Céleste Boursier-Mougenot, a french artist initially trained as a musician, creates installations that merge sound and movement, exploiting the unique characteristics of a location to let emerge works of art that evolve through their surrounding environment. *Off Road* is a mechanical ballet involving three motorized pianos (Figure 1) that move slowly and in a random fashion inside the exhibition room¹.

In evaluating audience experience with interactive artworks, observational and qualitative research methods are generally used [11, 12]. Those methods

are meant to evaluate whether the audience experience relates to the artist intentions or if the audience appreciated the artwork. In this study, the evaluation of audience's experience with a behavioral artwork is not targeted at the aesthetic level (pleasure, goodness, beauty) [13, 14] but rather at the type of audience engagement with the artwork, that is the degree to which a visitor is willing to approach and interact with the artwork.

Examining the physical displacements and behaviors of visitors inside an artistic installation provide a unique opportunity to evaluate how they position themselves spatially with respect to an artwork, and the type of interaction prompted by it. Techniques and tools from ethnomethodology [15] and from HCI [4, 16] have been deployed to understand the audience experience. If such an experience may be deemed profoundly subjective in essence, these approaches suggest that visitors can be categorized according to stereotyped behaviors. [7] describe for instance 8 categories of audience behavior. Among them the "*Stop-and-observe*": visitors that stand still for a short while before leaving the installation; "*Skimmer*": visitors that evolve slowly round the room; "*Serious, quiet and contemplative engagement*": visitors that spend a long time trying to immerse themselves inside the installation. These three categories indicate stereotyped visit patterns that can be observed consistently across visitors, possibly revealing some personality traits and possibly related to motivational components [5].

In the same spirit, we propose a data-driven approach to reveal visit patterns when an audience is confronted to a behavioral artwork. Through a cluster analysis performed on visitors' path inside an installation room,

¹ <https://www.youtube.com/watch?v=0y01Ghx2Lxc>

we highlight some patterns of approach or withdrawal, passive observation or exploration. We also examine how these patterns relate to variations in the artwork's movements.

Method

Setting

The pianos, as well as the visitors, were captured by a webcam located on the ceiling of the room. The pianos and the visitors' movements were tracked through an algorithm based on contour recognition. The recording of the audience behavior inside the installation's room took place during three entire days.

Algorithm for the pianos movement

The pianos are mounted on wheels. The wheels are coupled up to electric motors through a bike chain. The motors receive commands from a computer located next to the installation room, this computer gets it input from a webcam located on the ceiling of the room and performs contour recognition to locate the pianos and the visitors' positions, which in turn determines the pianos evolution inside the room. The pianos obey to a sort of virtual landscape in constant evolution that simulates upslopes and downslopes such that pianos are 'sliding' on these slopes. Walls create a virtual downslope, such that a piano approaching from the wall would turn back. Pianos tend to be repelled by each other, although they can sometimes (gently) collide. Through the use of an anemometer, the speed of the wind outside the speed of the wind outside the museum is measured and has a subtle influence on the way the pianos interact. For instance, when the wind is regular, the pianos tend to be attracted toward each other. In principle, the visitors cannot influence the pianos' movements. However a mechanism has been

implemented that allows one single visitor at a time to do such a thing. While the room is divided into several zones, the direction of the wind is measured determining which zone is selected. If a visitor is inside this zone she will be able to repel the pianos.

Visitors' selection and video analysis procedure

We used three days of recordings from the ceiling camera of the exhibition room. These recordings depict the installation in its full extent with visitors roaming around the pianos (Figure 2). However, we kept only a portion of the total recording, picking up the sequences in which no more than 10 people were simultaneously present inside the room and, among these sequences, those in which the visitor had no interaction with other people. In total, 120 sequences were selected each corresponding to a visitor's path inside the installation.

The visitors and the pianos' trajectories were extracted with Mocha from Adobe After Effect; their position (in pixels) was measured for each frame, on a 25 frames per second basis. We developed a software in order to evaluate some variables regarding the visitors' position and some temporal aspects of their visit. To do so, we delineated two different zones inside the video frame: While the dimensions of the room are 580 x 711 pixels, we drawn a 520 x 680 rectangle inside this space (see Figure 2) to delimit an area ('visit zone') where visitors are considered to be evolving among the pianos instead of staying withdrawn and observe passively from the edge of the installation ('edge zone'). To determine the time spent interacting directly with the pianos, we considered that a visitor was in interaction with a piano each time she entered a 100 pixels diameter circle around a piano center ('piano zone'). Furthermore, we

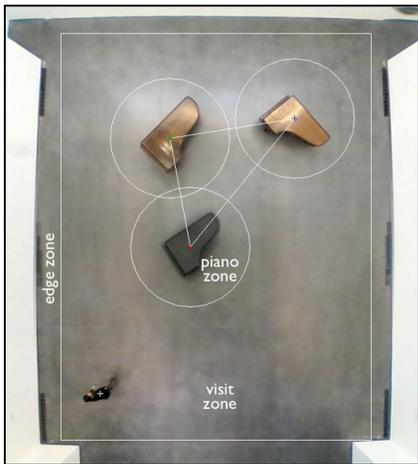


Figure 2. Three different zones inside the installation room.

considered that a visitor is in a passive watching state each time she spends more than 0.8s standstill.

We measured the 8 following variables (for each visitor, in pixels and in seconds - the durations are normalized with respect to the total visit duration):

- Overall visit duration
- Overall distance travelled
- Average walking speed
- Average distance to the three pianos
- Average distance to the closest piano (whose identity vary from frame to frame)
- Time spent inside the 'piano zone'
- Time spent inside the 'edge zone'
- Time spent in a watching state.

Cluster analysis procedure

In order to let emerge different patterns of behaviors among visitors from the data, we performed a C-Medoids clustering analysis [17]. To determine the relevant number of clusters, we used the "elbow method" [18] with a threshold of explained variance set at 80%. To find out the variables combinations that let emerge a reasonable number of clusters, we tested all these combinations with two constraints: at least 2 variables are considered, and a maximum of 4 clusters have to emerge.

Results

Among all the 256 possible combinations, only 4 let emerge a maximum of 4 clusters: average distance to the pianos and average distance to the closest piano; average distance to the pianos and time spent in the

piano zone; average distance to the closest piano and time spent in the piano zone; and time spent in the piano zone and time spent in the edge zone. Inasmuch as the first three pairs concern variables related to each other, we only considered the last combination.

Considering the time spent in the piano zone and the time spent in the edge zone, 4 clusters emerge: the first (C1) and the second (C2) correspond to visitors that tend to spend a short time both inside the visit zone and in the proximity of the pianos. The third cluster (C3) corresponds to visitors that tend to spend a long time at the edge of the installation and tend to avoid close encounters with the pianos. Visitors from the fourth cluster (C4) have the opposite behavior: they tend to spend a long time close to the pianos and a very short time at the edge of the visit zone.

In the following analyses, we do not consider the average distance to the pianos since this variable is related to the distance to the nearest piano. To ensure that the visitors clusters we obtained are statistically different from each other, we performed an ANOVA with clusters as independent factor on the different parameters (Tab. 1). The clusters differ significantly regarding the time spent in the piano zone, the time spent in the edge zone, and the time spent in a watching state. However they do not differ with respect to variables related to the overall time spent inside the exhibition room or to the scene dynamic: the visit duration, the travelled distance and the average velocity, average distance between pianos, and mean velocity of pianos. The results indicate therefore that the groups we found differentiate according to parameters related to the spatial interaction with the artwork.

	C1	C2	C3	C4
number of visitors	33	30	31	26
visit time	20,75	16,03	22,99	20,48
distance travelled	1217	1278	1224	1434
speed	5,41	5,44	5,81	5,55
distance to closest piano	183	225	276	135
time in piano zone	0,055	0,022	0,018	0,451
time in edge zone	0,098	0,331	0,766	0,1
time watching	0,318	0,157	0,375	0,249

Table 1. Mean values (in pixels and seconds) for the different visit variables as a function of the visitors clusters.

We performed post-hoc tests (Tukey's HSD) on average distance to the nearest piano, time inside the piano zone, time inside the edge zone, and time in a watching state. Regarding the average distance to the nearest piano, all the clusters are differing from each other. Visitors in C3 are on average the farthest from the pianos, whereas those in C4 are the closest. C4 is the only cluster to differentiate significantly from the other groups with respect to the time in the piano zone. Regarding the time spent in the edge zone, C4 and C1 differ significantly from the other groups but do not differ from each other. Regarding the time spent in a watching state, C1 and C2 differ significantly from each other, as well as C2 and C3.

Four different profiles emerge that represent four different ways to engage with the installation. Certain visitors have a pattern of withdrawal (C3), staying at the edge of the installation, contemplating quietly the pianos as they move around. On the opposite side, certain visitors (C4) engage directly with the artwork, spending time in the immediate proximity of the pianos, trying sometimes to seek an interaction with them. Somewhere in between, visitors adopt a mix of these two fundamental attitudes. Some (C1) stay relatively close to the pianos (while not in contact), remaining relatively standstill. Some (C2) adopt a more cautious (or perhaps indifferent) attitude; farther from the pianos they also change their position more often.

We could surmise that the artwork, due to its behavioral properties, is prompting these patterns of approach and withdrawal. This would require to be tested comparing the variations of these patterns depending on the mobility of the artwork. Since we could not control directly the pianos' mobility, we

evaluated if the pianos' dynamic, measured by the average distance between the pianos (i.e. the total length of the triangle formed by the pianos) and their average speed (i.e. the sum of the average speed of each piano), had an impact on visitors' trajectory.

We evaluated the correlation between the variables related to the pianos' movements and the variables related to audience behavior (Tab.2). We found a small yet significant correlation between the pianos average speed and the visit duration ($r^2 = .189$; $p < .05$). The average walking speed seems also to be correlated with the distance between the pianos ($r^2 = .213$; $p < .05$). Visitors tend to stay longer inside the installation room when the pianos are moving faster, and they tend to walk more slowly when the pianos are more scattered. The impact of the pianos' dynamic seems to depend on the previously identified clusters. Walking speed and average pianos separation are negatively correlated for C2 ($r^2 = .549$; $p < .005$), while we found a correlation between pianos' speed and distance to the pianos for C1 ($r^2 = .425$; $p < .05$), indicating that these visitors tend to distance themselves from the pianos as they move faster.

In sum, the way the pianos move inside the installation seems to have an influence on audience behavior, although only for a portion of the audience. Some visitors remain at the edge on the installation no matter what (C3), while other visitors interact directly with the pianos no matter what (C4). The remaining visitors (C1 & C2) are those adjusting their behavior according to the pianos evolution inside the room: C1s, more engaged into the visit zone, adjust their distance as a function of pianos' movements; C2s, less engaged, move more slowly as the pianos are more scattered.

Summary and discussion

Through a cluster analysis performed on an audience reacting to autonomous objects, we see different profiles emerge, corresponding to different ways to engage with a behavioral artwork. Distinct patterns of exploration and observation characterize four groups of the approximately same size of visitors. Some visitors may be considered “explorers” in that they engage systematically with the artwork; some others are “stalkers”, contemplating the work from a distance. Aside these two extreme groups, some visitors have a more flexible behavior: they approach then retreat, they observe, and they adjust their distance and pace as a function of the pianos’ speed and the way they are scattered inside the room.

The choice to approach the artwork, to interact directly with it, or, on the contrary, to stay at the edge, observing passively, represent different ways to appreciate the artwork. The visit patterns echo the aesthetic pleasures the artwork offers to the visitor. A behavioral object is not something only to contemplate, but something you can engage with, something that you can test through micro-interactions (in the case of *Off Road* people try to come as close as possible from the pianos to observe if they are reacting to their presence) to gauge the range of its reactions. The behavioral properties of the artwork prompt curiosity in the visitors, but may also invite caution.

Thus, this is through a very specific combination of properties that a behavioral artwork shapes the audience experience. Some interaction patterns arise from immediate feedback given by basic motion cue, while others come from higher-order attributions regarding the object’s psychological properties. An

investigation of the audience attributions and expectations regarding the artwork would be necessary to qualify the audience experience, but from the visit patterns we observe we can suggest a range of different pleasures and associated motivations that may explain the variation in audience behavior. Following [5], a combination of the pleasure one gets from exploring an unfamiliar setting and the pleasure one gets from figuring out how something ticks may account for the “explorer” profile. The “stalker” profile is probably more related to a perceptive pleasure drawn from the act of contemplating something whose evolution cannot be easily predicted.

Taking into account the modalities of engagement with a behavioral artwork is an opportunity for artists and curators to devise their work according to visitors profiles. In the future, drawing a systematic relationship between the psychological inferences drawn from motion cues and the emerging patterns of interaction would allow to understand the nature of the aesthetic experience derived from the contemplation of this original kind of entities that are now populating our museums.

Acknowledgements

We would like to thank Céleste Boursier-Mougenot and the Abattoirs team for kindly letting us investigate the installation. This study was made possible with the help of Samuel Bianchini, Emanuele Quinz, and Naoko Abe. This publication is part of a research program (The Behaviors of Things) that is supported by the Labex Arts-H2H, by Investissements d’Avenir (ANR-10-LABX-80-01) of the French National Research Agency (ANR).

References

- [1] Bianchini S., Bourganel R., Quinz E., Levillain F., Zibetti E., *(Mis)Behavioral objects. Empowerment of users vs. empowerment of objects*, in *Empowering Users through Design*, Bihanic D. Ed., Springer, 2015, pp. 129-152.
- [2] Cornock, S., & Edmonds, E. (1973). The creative process where the artist is amplified or superseded by the computer. *Leonardo*, 11-16.
- [3] Rutherford, M.D., & Kuhlmeier, V.A. (2013). Section introduction: The perception of animacy and intentional behavior. In M.D. Rutherford & V.A. Kuhlmeier (Eds) *Social Perception*. MIT Press.
- [4] Höök, K., Sengers, P., & Andersson, G. (2003, April). Sense and sensibility: evaluation and interactive art. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 241-248). ACM.
- [5] Costello, B., & Edmonds, E. (2007) A study in play, pleasure and interaction design. In *Proceedings of the 2007 conference on Designing pleasurable products and interfaces* (pp. 76-91). ACM.
- [6] Bilda, Z., Muller, L., & Edmonds, E. (2009). Artist, evaluator and curator: three viewpoints on interactive art, evaluation and audience experience. *Digital Creativity*, 20(3), 141-151.
- [7] Loke, L., & Robertson, T. (2009). Design representations of moving bodies for interactive, motion-sensing spaces. *Int.J.Human-Computer Studies*, 67, 394-410.
- [8] Boehner, K., Thom-Santelli, J., Zoss, A., Gay, G., Hall, J. S., & Barrett, T. (2005, April). Imprints of place: creative expressions of the museum experience. In *CHI'05 extended abstracts on Human factors in computing systems* (pp. 1220-1223). ACM.
- [9] Edmonds, E., Muller, L., & Connell, M. (2006). On creative engagement. *Visual Communication*, 5(3), 307-322.
- [10] Saerbeck, M., & Bartneck, C. (2010). Attribution of affect to robot motion. Proceedings of the 5th ACM/IEEE International Conference on Human-Robot Interaction, Osaka pp. 53-60.
- [11] Bilda, Z (2006) Evaluating audience experience Engage: interaction, art and audience experience. Creativity and Cognition Studios Press, Australia 248-260
- [12] Candy, L, Amitani, S and Bilda, Z (2006) Practice-led strategies for interactive art research, CoDesign: International Journal of Co Creation in Design and the Arts Vol 3 pp 209e223
- [13] Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with computers*, 13(2), 127-145.
- [14] Hassenzahl, M. (2004). The interplay of beauty, goodness, and usability in interactive products. *Human-Computer Interaction*, 19(4), 319-349.
- [15] Vom Lehn, D., Heath, C., & Hindmarsh, J. (2001). Exhibiting interaction: Conduct and collaboration in museums and galleries. *Symbolic Interaction*, 24(2), 189-216.
- [16] Costello, B., Muller, L., Amitani, S., Edmonds, E. (2000). Understanding the experience of interactive art: iamascope in beta_space. In Pisan, Y. (Ed.), Australasian Conference on Interactive Entertainment. Creativity and Cognition Studio Press, pp. 49-56.
- [17] Krishnapuram, R., Joshi, A., & Yi, L. (1999, August). A fuzzy relative of the k-medoids algorithm with application to web document and snippet clustering. In Fuzzy Systems Conference Proceedings, 1999. FUZZ-IEEE'99. 1999 IEEE International (Vol. 3, pp. 1281-1286). IEEE.
- [18] Thorndike, R. L. (1953). Who belongs in the family? *Psychometrika*, 18(4), 267-276.