

# DEVELOPING AN “ANTIGENOUS” ART INSTALLATION BASED ON A TOUCHLESS ENDO- SYSTEM INTERFACE

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## ABSTRACT

*Antigenous* is an immersive interactive installation model where the full-body gestures of the audience-participant, generate, interact with and modify the sonic expressions and the post-image impressions emanating from the interaction processes itself.

The work is a metaphoric representation of the antigenous reaction caused by a foreign body invading an organism - the installation is composed of a touchless interface based on sensorial receptor technology. The receptors act as a reagent to the intruders' presence and actions, and the system's antibodies, comprised of melodic and verbal sonic elements create a dialogue that transit between chaotic and harmonious synchronization, evoking sonic elements based on a sensorial pre-human, human and post-human repertoire.

As an endo-instrument which is “played” without any physical contact, a systemic dialogue is created between contemporary electronic music, distorted environmental sounds and people's active gestures, momentarily catapulting the interactors into the simultaneous roles of composer, musician and performer.

## Keywords

human computer interface, motion sensors, music composition, interactive performance, immersive dance, audience participant, full-body movement, generative art, mapping layer

## 1. INTRODUCTION

This paper presents the architecture for a touchless interactive endo-system and a discussion of the endo-aesthetic factors that it involves. By interfacing a network of sensors with a control system based on self-generative processes and a non-linear mapping system, a highly interactive immersive installation

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was developed that permits highly collaborative expression. Visual and audio elements both stimulate and respond to the interactor's movement and corporal expressions, creating a rich environment that creatively integrates the auditory, the visual, and the gestural into a unified interactive experience that encourages the interactor to explore movements and gestures that go beyond their habitual corporal expressions.

A creative attempt is made to integrate the most recent schools of thought, with current research, technologies and interfaces that focus on systemic processes between humans and artificial means of communication.

“As evidenced by the popularity of both the Nintendo Wii and Dance Revolution, the full use of one's body in controlling an interactive experience is showing itself to be what people are looking for in their play experiences” [1]. In this paper, new design scenarios are explored through the use of an interactive immersive system with the objective of developing a more holistic audiovisual and kinesthetic interaction design.

## 2. ANTIGENOUS: The paradox of contact without contact

The aesthetic proposal of this installation highlights the interactivity and the human-machine relationship within an endo-system. As a metaphor, we use an organism's antigenous reaction which is evoked when “invaded” by foreign bodies. This reflects the interdependent relationship between humans and the environments that they are exposed to.

Antigenous has an intra-organic ecology – one being is inside the other. In one sense there has to be some form of contact between them since one is totally immersed in the other, yet, paradoxically, there is no physical contact at all. It hints at a radicalization of the physical contact between one body inside another (like a systemic structure) which is characterized by the total absence of contact in a paradoxically inverted relationship.

In *Antigenous* the participants are inside the environment like an antigen inside an organism and consequently experience the sonic and visual “consequences” of the organism's antigenous reaction to their presence. Furthermore, the experiment demonstrates how destructive the consequence of

human behaviour can be on our relationship with the natural environment in which we have been created, and conversely how constructive our behaviour can be within artificial systems created by us.

This work is inspired by some of the recent tendencies in the field of immersive art and interactive environments, with a strong influence from endo-aesthetics where the interface device becomes more and more prevalent [2-5].

### 3. AN ENDO-SYSTEMIC ENVIRONMENT

#### 3.1 Audience As Participant – Holistic Endo-Instrumental Interactivity

There is a growing interest in developing techniques that can be used to allow audiences be more participatory in artistic performances and it is interesting to incorporate this partnership into the compositional process. [6, 7]

The system functions in real-time and acquires information about human full-body movement via the distance and movement sensors, processes this data and converts it into a sonic and visual feedback experience.

#### 3.2 Interface Concept and Design

Firstly, in designing the endo-system we wanted an immersive environment void of any apparatus, accessory or device that involved interaction via touch. Secondly, we wanted a touchless interface that could trigger a variety of prerecorded sound samples, create computer-generated sounds, and control MIDI instruments. Thirdly, the sensitivity of the system needed to be modifiable. The fourth criteria was that we wanted a controller response that was more than a simple ON/OFF system so that the sensorial aspect would not be a simple binary one. Lastly, the flexibility of the system had to be such that it would react to one person simultaneously activating multiple sensors and/or multiple participants interacting collectively.

##### 3.2.1 Basic Layout

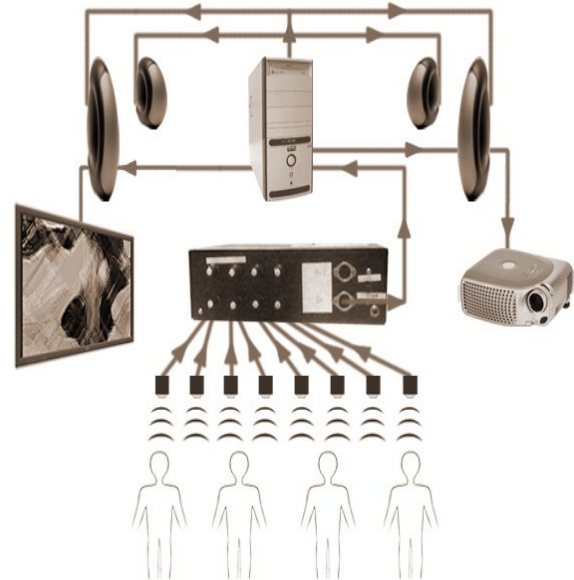
A typical layout includes the following elements fixed to walls and ceiling:

- a) Sensors that detect the movement and distance of participants. In larger spaces, extra sensors are included in cylinders suspended from the ceiling.
- b) Sound system that includes multiple speakers up to 7.1 surround sound.
- c) Visual elements include lasers that sketch rapid and undulating luminous traces corresponding to the distorted sonic events generated by participants.

##### 3.2.2 Hardware

The interface contains a Parallax Basic Stamp IISX microprocessor module coupled to PING)) ultrasonic sensors [8]. No A/D conversion is needed as the sensors communicate directly with the Basic Stamp. The microprocessor has an EEPROM memory which can be accessed from a PC using pBasic. The custom-built interface is connected to the computer via a standard MIDI interface cable. Since the algorithms are stored in the EEPROM of the interface, it is possible to connect the controller directly to a stand-alone MIDI device without the need for a computer.

The sensors are plugged directly into the interface as shown in the schematic illustration in Figure 1 and powered directly from the unit. The ultrasonic sensors are sensitive to gestures within a 2m range, and the sonic beam width is quite narrow (about 45cm).



**Figure 1. A schematic representation of the hardware elements in a typical layout. It shows the custom-built interface controller, the sensors, peripheral devices and audience-participants.**

##### 3.2.3 Sonic Structure, Software and Soundbanks

The software synthesizer component of this application example uses Propellerhead Reason 4.0. It is an audio software suite that emulates a variety of different real-world audio devices, sound generators and synthesizers and allows the devices to be interconnected in a myriad of ways. Furthermore, hundreds of the virtual devices' functions can be controlled via MIDI commands coming from the sensor interface. The sound synthesis therefore occurs in the central computer system rather than in the interface, opening up unlimited possibilities for sound manipulation via algorithms and other programs. In this way, a wider spectrum of timbres and effects can be accessed with continuous real-time control over many sound parameters.

The software synthesizer offers the possibility of directly accessing a soundbank and manipulating samples using any combination of effects that can stimulate, shock (even frighten!), intrigue and provoke the interactor to explore and confront the constantly mutating sonic environment.

In this installation, audio clusters are composed of single notes, various beats, melodic and phonetic arrangements composed of verbal expressions, human interjections (shouts, cries etc), and harmonies and timbres suggestive of organic sounds metaphorically derived from introspective machine-based sounds. When triggered individually or collectively, they are expressed with impact and include infra- and ultra-sonic frequencies inducing an emotional effect on people, through a more narrative and less environmental sound structure.

##### 3.2.4 Visual Feedback Generation

In order to confine the participatory experience to the aural-gestural relationship, the visual architecture was somewhat

minimalist - lasers react neuralgically and emit short oscillating wave bursts when a body is within a limited radius to a sensor (<2m). Events are triggered by provocative gestures such as a rapid change in distance or multiple movements in and out of a sensor's line of detection. The lasers used were typically extracted from commercial pointing devices and fixed to the walls.

The subtle intermittent visual laser component is interesting in that it also plays the role of "antibody" and the variations in its luminescent bursts are "reactions" to the presence or interference of the audience-participants. These reactions tend to increase the interdependency of the interactors with their sensorial orientation, since the laser bursts help guide the activation and transformation.

### 3.2.5 The Multi-Parametric Gesture Mapping Layer

It has been previously reported that the psychological and emotional response elicited in the participant is determined to a great extent by the mapping [9]. With this in mind, the mapping for this experiment was chosen such that once inside *Antigenous* the interactor's need to keep moving gives him the impression that it is his own energy that is responsible for the sound. This involved a multi-parametric mapping system involving algorithms as opposed to a simple one-to-one relationship between a controller and a variable. This mapping approach has been underlined in a previous work - "The advantages of such systems include the computer's ability to expand simple but powerful instructions into coordinated controls for multitudes of variables, to redefine controls in different contexts, and to maintain goal-orientation while introducing enough unpredictability to keep the instrument interesting." [10]

The mapping layer also includes self-generative processes, and permits the creative combination of sound matrices based on algorithms which react to the presence and movement information captured by the sensors.

Furthermore, the mapping layer also controls the visual events which simultaneously trigger lasers to "etch" wave shapes onto the target bodies, like an antigenous defense system reacting to a "foreign body". The reaction of the interactors to the audio and visual experience causes them to behave in a particular way and this behaviour is fed back into the system generating an infinitely varying feedback response - each interaction-performance is unique and the combinations and permutations are limitless.

Two mapping systems were explored:

- a) Simple One-to-One Mapping: The relationship between a sensor is directly linked to only one controller parameter.
- b) Complex Cross-Coupled Mapping: The sensor data from one or more sensors is cross-coupled to more than one parameter in the sound-generating process or algorithms.

It is possible to completely change the installation's behavior by simply changing the mapping layer between the controllers and the soundbank/synthesizer algorithms: the rate of change of one parameter can be scaled, clipped, multiplied, inverted, etc., by another parameter (controlled by one sensor), thus progressively distorting and shaping the sonic work. The rhythm of a background beat can be modulated by rapid movements on a specific sensor. When two interactors are at the same distance from a third and fourth sensor, a fifth sensor is programmed to pan the sounds.

The interactive area is considered to have hotspots at the points of intersection of certain sensor beams. When a body is detected at such a hotspot, an algorithm randomly (or in a predetermined manner) causes a generative change: initiates a new sonic cluster, resets the whole system, distorts the sonic work, or activates a constant rhythmic beat. Furthermore, cross-coupling between variables can easily be created and destroyed via these algorithms.

## 4. RESULTS

The generative combinations which are created, accessed and transformed, turn the interactive environment into an endo-instrument from within which the poetic sonic experiences emanate, not only evoking a concrete and deconstructive art, but producing an interactive potential not previously experienced. The "apparent chaos" which is provoked by both individual and collective actions can eventually become more harmonized through the manner in which the participants distribute themselves spatially and in accordance with their individual and collective gestures.

It is via the mapping layers that the apparent dissonant sonic response to an "invasion" can be manipulated and restructured by the interactors, allowing them to transform the "repellant chaos" into a more "integrated harmony", and eventually into an experience that is essentially musical. The type and level of interaction of an individual or a group of individuals determines the level of acceptance or rejection of the being or beings by the system. In *Antigenous*, participants' behavior and interest are stimulated by using algorithms that cause some unpredictable behaviors at the synthesis/sonic level. As Hunt and Wanderley already reported, complex mappings must be practiced and explored in order to achieve truly expressive output [9]. Furthermore, Joel Chadabe observes that an indeterministic instrument outputs a substantial amount of unpredictable information relative to a performer's controls. "In working with such an instrument, a performer shares control of the music with algorithms as virtual co-performers such that the instrument generates unpredictable information to which the performer reacts, the performer generates control information to which the instrument reacts, and the performer and instrument seem to engage in a conversation" [10]. By Chadabe's definition, *Antigenous* is therefore more than an installation - it is an 'interactive instrument'. Yet within the *Antigenous* paradox, this endo-instrument is more of a *non-instrument*.

### 4.1 Aesthetic Analysis of the Interactivity and Gestural Expressivity

From the point of view of its mode of action, the *Antigenous* installation "dialogizes" principally with a Cunningham-Cagean aesthetic typical of the latter end of the 60s, yet here, catapults us into a somewhat analogous semiotic realm, especially by the fact that the audience is evoked to perform gestures determinant for this type of composition in a manner which is live, liberal, collective and physically disconnected from the machine.

Some of the algorithms that interpret the interactions are controlled by a generative process that includes a random element which prevents the same sonic experience being repeated even when the same movement or gesture is detected. This means that each "invasion" by an individual causes a reaction to the "internal organism" that is not always predictable. The sensorial effect of each movement that evokes a modification in the sonic response entices the participant

into a more intimate coexistence and personal dialogue with each region with which he interacts.

Through its intra-organic ecology metaphor, the installation proposes a paradoxical discourse about contact, which is not direct contact, between two different “beings”. The immersive environment dialogizes in terms of radicalizing physical contact in the absence of physical contact. The technological endo-instrumental basis of this experiment reaffirms a tendency that is establishing itself more and more firmly in the art world, one which involves systemic extension theories from Marshall McLuhan [12] to Cláudia Gianetti [13] and which has been gathering ever-increasing expressive values of an artistic, scientific and intellectual nature for more than forty years.

Furthermore, this causes an intertwining of the interactive musical fundamentals of Marcelo Wanderley [15] and the artworks of Karmenk, Franinovic [16] and Eric Lee [17] in relation to the gestures in sonic music involving technological interventions, with the serial music of Cage and the expressive gestures in music and dance performance of Cunningham [18] in an aesthetic innovative pantheon embracing a more collective and dialogic paradigm.

Being less instrumental than Wanderley, less environmental than Franinovic and more abstract than Lee, *Antigenous* nonetheless dialogues with these works at certain levels including the mapping system of the first, the aerial sensor configuration of the second and the abstract sonic aspect of the melodic and phonetic elements of the third.

During each interaction the participants within the installation enclosure, both control and are controlled by the audio zones producing, modifying and transmitting information in real-time. A new combination of sounds, a new harmonic content significance is created and then ceases as the movement dies down, with only a perception lingering. The quantity of audio information, rhythmic cadences, the phonetic and harmonic depends exclusively on the quantity and extent of movement of the person's body or limbs within the interactive space, just like a performer/dancer. The generative variants include the person's expressivity, the number of people interacting and the trajectory taken.

## 5. CONCLUSION

This work aims to demonstrate a different application of a human-computer communication interface where the expressive interactive aspect of the setup brings out ordinary people's intelligence, imagination, and corporal expressivity in both individual and collective situations.

The installation's behaviour and level of interactivity are affected dramatically by the mapping layer used between the controller and the sonic generation process – this means that what the interactor experiences varies as a function of the mapping layer.

It allows an individual or group of people to use corporal gestures, in the absence of any physical contact, in a way that their expressive movements and corporal narratives generate the audiovisual experience. As such, both the participants and installation engage in a poetic and sonic conversation that definitively places the emphasis of this work on the sonic art emanating from the installation more so than on the technology of the interface itself

## REFERENCES

- [1] Keating, Noah H. The Lambent Reactive: An Audiovisual Environment for Kinesthetic Playforms. In *Proceedings of the 2007 Conference on New Interfaces for Musical Expression (NIME07)*. 2007, 338-343.
- [2] Giannachi, Gabriela. *Virtual Theatres: An Introduction*. London : Routledge, 2004.
- [3] Utterback, Camille. An Experience with Your Body in Space. *Untitled 5 (a generative artwork)* 2005. Available at <http://www.camilleutterback.com>.
- [4] Weibel, Peter. The Intelligent Image: Neurocinema or Quantum Cinema? *A lesson from the course: "Algorithmic Art. From Cezanne to the Computer"*. MECAD, 2004.
- [5] Costanza, E., Shelley, S.B. and Robinson, J. Introducing Audio d-touch: a Novel Tangible User Interface for Music Composition and Performance. In *Proceedings of the 6th international conference on digital audio effects (DAFx03)*. 2003.
- [6] Hansen, Mark. *New Philosophy for New Media*. Cambridge : MIT Press, 2004.
- [7] Manovich, L. *The Language of New Media*. MA: MIT press, 2002.
- [8] Parallax -microcontrollers and development tools. *Parallax*. Available at <http://www.parallax.com/>.
- [9] Hunt, A., Wanderley, M. and Paradis, M. The Importance of Parameter Mapping in Electronic Instrument Design. *Proceedings of the 2002 Conference on New Instruments for Musical Expression*, Dublin (NIME-02), 149-154.
- [10] Chadabe, Joel. The Limitations of Mapping as a Structural Descriptive in Electronic Instruments. *Proceedings of the 2002 Conference on New interfaces for Musical Expression*. 2002, 1-5.
- [11] Gianetti, Cláudia. Endo-Aesthetics – From Ontological Discourse to System Argumentation. *Media Art Net – 2004*. <http://netart.incubadora.fapesp.br/porta/referencias/endoaesthetics.pdf>.
- [12] McLuhan, M. *Understanding Media: The Extensions of Man*. Cambridge : MIT Press, 1964.
- [13] Giannetti, Claudia. *Estética Digital -Sintopia da arte, a ciência e a tecnologia*. Belo Horizonte : C/Arte, 2006.
- [14] Bighetti, Vera. The generative art of Vera Bighetti. *Vera Bighetti's website*. Available at <http://www.artzero.net>.
- [15] Malloch, J., Sinclair, S., and Wanderley, M. From Controller to Sound: Tools for Collaborative Development of Digital Musical Instruments.” *Proceedings of the 2007 International Computer Music Conference*, Copenhagen, Denmark.
- [16] Francinovic, K., Visell, Y. New musical interfaces in context: Sonic Interaction Design for Urban Setting. New York, NIME07, 2007.
- [17] Eric Lee, Marius Wolf, Yvonne Jansen and Jan Borchers Multi-User Interactive Exhibit For Exploring Medieval Music. *Conference on New Interfaces for Musical Expression (NIME07)*, New York, NY, USA 2007.
- [18] Santana, Ivani. *Corpo aberto: Cunningham, Dança e Novas Tecnologias*. São Paulo : EDUC: FAPESP, 2002.