TURBA Concert in 15 Movements for 64 Neural Xoscillators

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Abstract

TURBA is a hybrid environment of artistic speculation that combines an electromechanical robotic device and its sonification with the network structure of 64 neural oscillators and the social context of the collective behaviors. None of the actions generated by TURBA is previously arranged: no sound, no movement, no pattern is deliberately produced. Quite the opposite, these elements come alive because of its own processes in its own network structure.

Keywords

Robotics, Neural Network, Contagion, Data, Sound Generation, Collective Behavior, Installation, kinetics

Introduction

TURBA is part of a wider investigation made from an artistic approach that deals with the subject of the concept of the human being by means of bodies, perceptions and metaphors coming from computer programming, robotics, life simulation or artificial life**.**

This research is called Codex Contaminari,_Humana Coded [1]. It consists of three intertwined parts: 'Turba' which generates and interprets emergent behavior patterns by a neural network; 'Uncanny Bihotz' concerned with the construction of the organic elements made up of synthetic units and 'Ehime Daruma' being a symbol of the thought transformation capacity onto the matter, this time, as a consequence of the virtual changing into the real.

Despite their digital nature, each of the three pieces also contain data from 'another human condition' brought by their own substantial contact, which is mainly conceived as the act of adding to the logic of the binary data variables of an irrational computing [2] or an alchemical logic. As a matter of fact, the three of them primarily aim at searching the poetical elements from the magnified data and once it is brought into an aesthetic experience, it undoubtedly enhances the perception of the hybrid beings technologically designed. In the case of TURBA, a network structure of 64 neural oscillators has been 'infected' with the meaning of other self-organized procedural systems of social or cultural nature.

Social Background: Collective Behavior and Contagion Theory

The Royal Spanish Academy dictionary defines *turba* as a crowd of confused and disorderly people. According to the thought of the social sciences a *turba* belongs to the category of collective behavior, mainly in accordance with the contagion theories. These theories were first developed by Gustave Le Bon (1895) [3], and later continued by Robert Park (1967) [4], and Herbert Blumer (1951) [5]. They defined a collective behavior as one that spontaneously arises, is relatively little organized, quite unpredictable, that has no development plans, and is dependent on the mutual stimulation among its participants.

In such situations there is often a free play of emotions, a high degree of personal interaction, influence and competition, and the emergence of opinions and transient submissions. So, the crowds exert a hypnotic influence over its members, which, protected by anonymity, leave their personal responsibility and surrender to the contagious emotions of the group. In this way, the crowd takes own life, causing emotions and leading its members to irrational action.

Depending on the context, the behaviors that may be included in it are: disaster, crowds, mobs, gangs, panics, rumors, extravagant fashions, mass hysteria, passing hobbies, propaganda, public opinion, social movements and revolutions. None of them is completely controlled by cultural norms.

Contagion theories seek to explain networks as conduits for "infectious" attitudes and behavior. These infected networks serve as a mechanism that exposes people, groups, and organizations to information, attitudinal messages and the behaviors of others

(Contractor & Eisenberg, 1990) [6]. Due to this exposure it increases the likelihood that network members will develop beliefs, assumptions, and attitudes similar to those of their networks (Carley & Kaufer, 1993) [7].

A *turba* is a crowd engaged in an aggressive act.

Technical Background: Neural Oscillators

The mathematical equations for the neural oscillators used in TURBA are based on the work of Shun-Ichi Amari (Amari, 1977) [8] and are specifically explained on the website of the Laboratory for Experimental Computer Science at the Academy of Media Arts Cologne [9]. In TURBA, these equations have been rigorously adapted to the visual programming environment vvvv (Figure 1) in order to create neural oscillators.

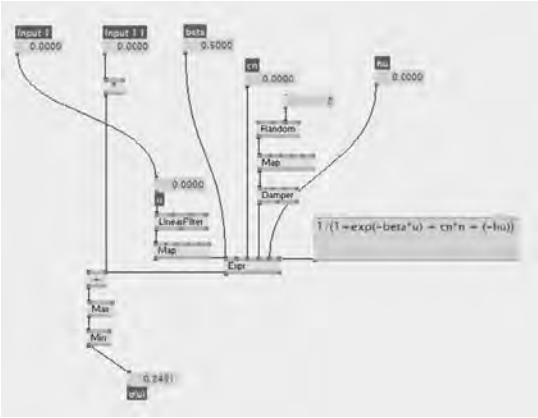

Figure 1. A neural oscillator core built in vvvv

A dynamical system describes the temporal evolution of a state variable in time. In case of the neural oscillators there are two state variables u and v that represent the neural activation level of the excitatory and of the inhibitory neuron. According to this explanation, neural oscillators allow creating rhythmic behavior. They can be realized with just two mathematical equations that describe the behavior of two mutually coupled systems in time. The first system is a self-excitatory neuron that has a positive feedback connection onto itself, so when it becomes active it activates itself even more.

A second system is an inhibitory neuron that is activated by a positive connection from the excitatory neuron and it sends back negative (inhibitory) feedback to the self-excitatory neuron. When the excitatory system becomes active it activates the inhibitory neuron that in turn suppresses the activation of the excitatory neuron (Figure 2). Once the excitatory neuron is de-activated the inhibitory neuron loses the positive input and becomes inactive. Now without the inhibitory input the excitatory neuron becomes active and activates the inhibitory neuron again. Then, like a little heart, a new cycle begins, creating rhythmic behaviors

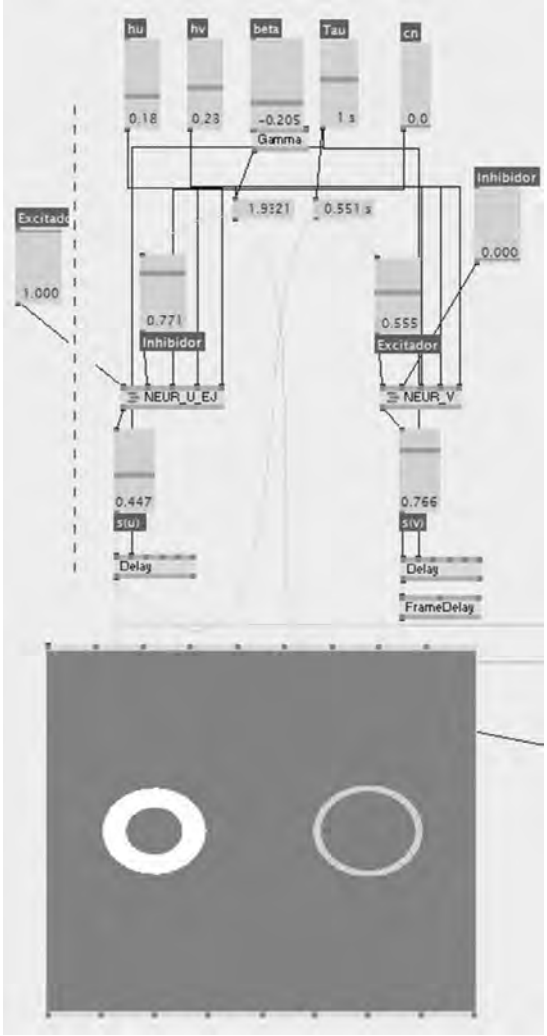

Figure 2. Two mutually coupled oscillator system

In TURBA a network of oscillators has been built through software (Figure 3). Each of the small boxes (nodes) of the following diagram is a couple of oscillators; from each of them, as synapsis in search of vital communication, three connections go out and other three connections come back. All of them have been randomly linked. To do this, we have followed a strictly random order process proposed by the program.

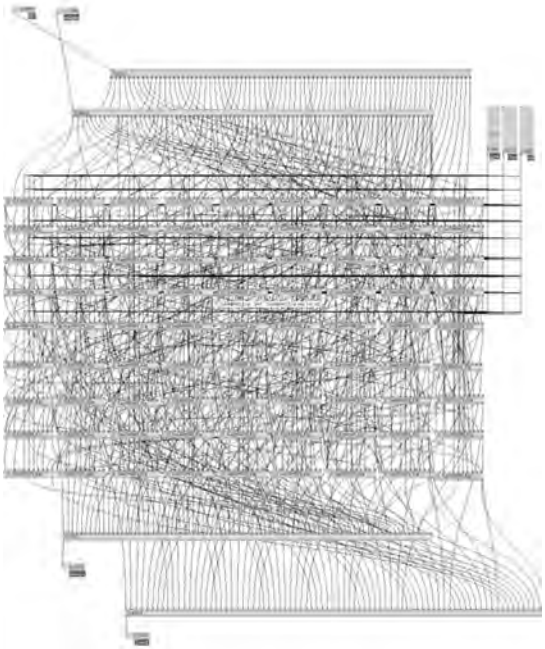

Figure 3. The oscillators' network

Up to here comes the explicit programming in oscillators' behavior: each excites and inhibits, and in turn, each is excited and inhibited by others. From here, all behavior arises from the structure itself. This means synchronization behavior is not explicitly programmed, but appears as a result of the network connectivity between the oscillators.

None of its components is the engine or timer for that behavior, but all act contagiously among them. We can say that the oscillators perform, but have no plans.

But if this system receives feedback from the synchronization that it generates, TURBA creates disturbingly similar rhythms to the movement of an organic body, carrying the work piece to emergent behaviors of asynchrony, chaos or collapses...

Hardware Background: The robotics

Physically, TURBA is a mechanical, electronic and sound installation. This structure consists of iron and aluminum, which supports 64 iron rods (Figure 4). Each of them contains a servo motor attached to grasses.

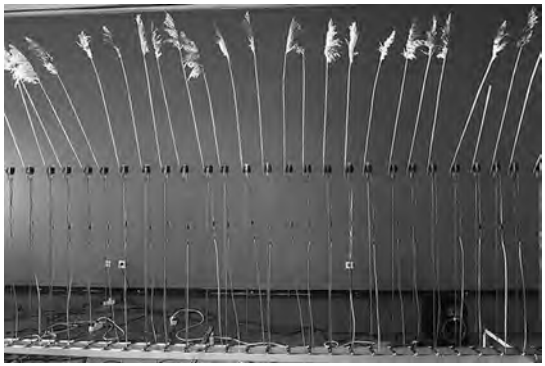

Figura 4. TURBA installation (view)

As a last resort, all this hardware structure has been built to understand, listen to and view the activity of the neural network of oscillators: what kind of patterns, classes and emergent behaviors arise from this peculiar nature. In this sense, the robotic structure of TURBA is strictly functional.

But since this hardware structure is also linked to an artistic and social meaning, part of its morphology is related to concepts of a symbolic staging. Herbs at the ends of the rods are grasses with a high power of contagion. Each time they move driven by the action of servo motors, they expand their seeds in the air, its active ingredients, their genes, their memes… (Figure 5)

Figure 5. Still of the motion generated by the servomotors

At the same time (Figure 6) the whole is illuminated by a light cross, creating a shadow that allows understand all individual slices as part of a group, where the personal characteristics have been removed, or to put it another way, where capabilities of own decision have been disappeared, devoured.

Figure 6. TURBA installation (view)

The Concert

TURBA has the subtitle of Concert in 15 movements for 64 neural oscillators. In the internal process of this structure, small changes in any of the parameters associated with the excitation and inhibition of the oscillators, will generate large changes in machine's performance. We have identified 15 moments (what later will be the movements of a piece of generative sound) in which this activity takes a special personality. Each of them has been named in Latin taking into account the metaphor that emerges from the generated movement:

1-Natus
2-Expergitus I
3-Expergitus II
4-Sinus I
5-Tesla I
6-Sinus II
7-Turba
8-Fedum
9-Spatha
10-Caro Data Vermibus
11- Exspectatĩo
12-Abyssalis
13-Collapsus
14-Addormiscere
15-Tesla II
16-Fine

In order to better understand each of these movements and the relationships among them, they have been carried to the sonification of a sound wavetable synthesis (Figure 7). From here, TURBA becomes an electroacoustic and acousmatic orchestra whose performers are the oscillators and the score is written in

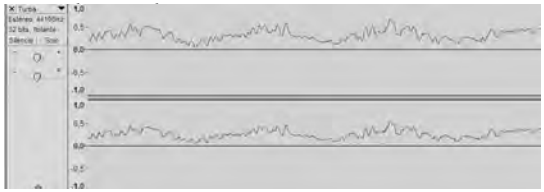

Figure 7. TURBA sound recording

Once the neural network has been built, it is permanently attached, or what is the same, oscillators always interpret the same score. But depending on the status ofsystem startup, or processor speed of the computer itself, or the order of the transitions from one movement to another, each of these interpretations is slightly different from each other.

Conclusions

The work serves to contemplate and understand a biological function in a mechanical context from artistic premises. What we see or listen to in TURBA, it is the activity of software entities and data in movement. These data have been led to the construction of a physical piece in a carefully prepared context, for a better understanding of what is happening inside the computer, but, in the end, as a mirror, it's built for a better understanding of what is happening out there.

Figure 8. TURBA installation (view)

On the one hand, it provides data to the discussion of collective behavior based on neural networks, and, on the other hand, it projects a scientifically measurable dimension in an artistic work. In addition, we thought the data are not abstract structures without body, even as software entities or raw data; they need a context, and they need to be balanced in a global system where there is a wider ecology between logical explanations and poetic insights. A crowd is not a network of neural oscillators, but they can behave or work in a similar way. In TURBA there has been constructed a mixture of elements that work together to be interpreted also in a joint way.

Links:Video: http://bit.ly/1M5YjZz
Sound: http://bit.ly/1WRksh7

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Author Biography

Patxi Araujo (Spain, 1967). Artist and Professor at the Department of Art and Technology (Faculty of Arts) at the University of the Basque Country UPV/EHU. Artist experienced in the field of fine arts, applied his research in scenery, installations and events, and in immersive and interactive environments. He has made numerous individual and collective exhibitions, receiving awards and mentions in different competitions and international events.

Currently his research focuses on the generation of content and critical thinking through the relocation of the work, the viewer and the artistic reason itself in the territory of the new media.