xTNZ – an evolutionary three-dimensional ecosystem
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Abstract - xTNZ is focused on the exploration of the possibilities of using artificial life in the context of art. The aim is to develop an ecosystem based on a real-time three-dimensional PC based system sustaining a “living” virtual environment. The entities populating this virtual world have been designed to be active and responsive. They behave and interact with each other, they reproduce according to eventual interactions and they change their own properties (such as sounds, visual appearance, or dimensions). An unpredictable visual representation of the world will emerge, shapes will evolve in time according to the autonomous creatures interaction.

Index Terms — Evolutionary Art, Artificial Life

I. INTRODUCTION
In contemporary digital culture, the social status of the computer has risen as a response to the development of its performance. The social impact of digital technology is remarkable. It has become omnipresent through TV, cellphones, GPS and email: it has impregnated the way we now live. The main motivation for this work is to express a comment on the digital culture. The result is a 3D world based on an initial human input, which evolves autonomously in an unpredictable way (within a predetermined set of possible states).

II. DESCRIPTION
The symbolic world chosen to represent the extended reality offered by computer technologies is a symbolic 3D world with living creatures. This utopian ecosystem consists of planets holding a community of plants and birds. Rainfalls energize the soil from which the plants feed. Birds fly around each planet foraging for food from plants. When these plants and birds die, they also energize the soil, in a complete food chain.

The creatures that populate the world have a natural life cycle: they are born, they feed, reproduce and eventually die. These specific behaviors such as the mating period or energy consummation are enabled according to the specific season of the “year”.

These entities make human-like sounds such as kissing or chewing, and they are visually represented with images from human body tissues – from internal organs, muscles and bones - digitally manipulated and applied as textures. The system inhibits reproductions when sensing the presence of a user/viewer. The user not only interferes by inhibiting mating behaviors, but also by making Birds scream and fly away.

The aesthetic evolution is produced when hybridization occurs in the reproduction of these populations. From these basic rules, and the interaction of their behaviors, complex social environments emerge, and new audio and visual representations occur.

2.1 The world entities and rules:

2.1.1 Seasons/Time:
The main system regulators are the days and the seasons. To emulate natural life cycles and introduce environmental energetic fluctuations, each system year is divided in 2 main periods: a dry and a wet season. The processes of growth and reproduction are triggered in specific days of each season. Each year has 20 days. And each day is a configurable number of milliseconds.

2.1.2 User action:
The user interacts with the world via the standard keyboard and mouse input and the screen as output. The navigation is free in the sense that it is not affected by gravity or any other physics law. Surfaces and creatures bodies are easily trespassed without any sort of constraint. The movements are uniform, however there are special keys to adjust their speed.

In addition, the actions of the user in the world influence the ecosystem. Creatures will not reproduce when sensing its presence (with keyboard and mouse movements); thus the user is considered an intruder and wounds the overall...
balance of the ecosystem. We have been inspired by real life ecosystems, where external agents introduce disturbance on the natural habitats, bringing about disturbance of the natural balance.

The user also plays a role in the soundscape. Each moving creature has a sound, which intensifies or decreases depending on the distance to the viewer.

2.1.3 The Clouds:

Clouds are particle systems moving over the planets. The function of the clouds is to energize the soil. According to the seasons they are more or less energetically charged. Their movements are continuous but chaotic along one planet. Therefore, they each follow a direction, which is determined by the previous two movements plus a randomized factor.

2.1.4 The Land/Planets:

Each planet supports an ecosystem consisting of all the families of each of the species. Planets are independent, therefore the ecosystems are also independent from each other.

Mainly Clouds, but also dead plants or dead birds energize the soil. The land functions as the place where plants locate and as a source of food. Its texture is almost transparent and changes according to the viewer position. The planets’ surfaces are undulated through sine and cosine functions as in Selman’s work [9]. The peak areas are produced using complex equations, which are different in each of the planets

The surface color reveals the system stress level. The color component changes, depending on the available memory of the computer. It changes from blue tonalities when the free memory available is higher than a threshold level and it decays to yellow tonalities when the system is running low on memory - according to a threshold table specifying pre-determined colors.

2.1.5 The Plants:

Three families of plants inhabit this world: Trolarindos, Imbuguzus and Chilinhos. This number of families allows a considerable variety of possible shapes when parents’ shapes are mixed in a newborn due to cross-reproduction. Considering an initial state with any two elements, it will produce one out of 6 possible shapes in contrast with the 3 possibilities when using only 2 families.

All three families belong to a same species, thus they all have the same basic rules: i) they have a variable life expectancy, which is calculated by the average of their parents life expectancy plus a random value; ii) they feed, consuming a fixed amount of energy from the soil in the position where they are located - however, when they find themselves in a dangerously low level of energy they shrink in size and consume yet more energy; iii) twice a year, once in each season and during a specific “mating” day, they mate and reproduce with other plants in their vicinity; iv) in the last ten years of life, trying to perpetuate their individual shapes, they can reproduce with other families producing hybrids, but this comes with a cost, because they also consume twice the amount of energy; v) when the system is running seriously low on memory, all reproductions are inhibited; vi) The only significant differences among the families are their shapes, textures, fertilization ranges and life expectancies. These two latter features are combined together, thus the longer the life expectancy the smaller the mating range, and vice-versa.

When reproducing, the offspring inherits the parent’s blended shape by mixing the information that describes the curvature of their parent’s leaves/branches.

The implementation of leaves uses Davidson’s [10] lathe3d class to produce 3d curved surfaces based on the revolution of a hermite curve. Hence, depending on the family they belong to, each plant has a specific number of coordinates (defining the curvature). This number is defined by the complexity of the initial family shape. During reproduction, the parents’ coordinates are averaged to produce the shape of the newborn. However, when the hybridization process occurs, the dominant parent will determine the number of points inherited (Fig 2).

The growing process considers the Plant in small segments that grow individually. This model is an adaptation of Davidson’s [10] and Teresi’s [11] growing trees algorithms. Both authors divide the trees growth process in small cylindrical segments. In this implementation we replaced the cylinders with the mentioned leaves/branches.

2.1.6 The Birds:

Three families of birds cohabit on xTNZ: Crystals Uipalalas and Tiroliros. The number of families...
implemented follows the same kind of principle as for Plants: A small number to illustrate the phylogenetic tree generated from these species. As individuals, Birds have a spherical shape. However, this appearance changes when they breed. In this situation, children are kept attached to the dominant parent until the parent dies. The way the parents aggregate their children varies between each species. For instance, Crystal’s parents aggregate their children around themselves in a bumpy shape. On the contrary, Tiroliro and Uipalala’s connect their children one after another in a continuous linear shape starting from one point on the parents’ bodies. This branch bends when they move. However, the former two families diverge slightly on the way this aggregation is made, since Uipalala’s children keep a visual autonomy, despite moving in sync with the mother, whereas the Tiroliro’s merge shapes.

Reproductive behaviors are triggered once a year during the dry season when mature Birds mate with the nearest mature Bird of the same family. The exception is when they are older than 50 years when, if they cannot find a family member to reproduce with, they can reproduce with members of other families, producing hybrids. These new birds keep the appearance and behavior of the dominant parent, but they memorize the one that is recessive. When there is more of this type of birds than “pure blood” members in one family, all the family members adopt a new sound and a new texture by blending these features with those of the recessive family that more contributed to the mutation.

All birds fly all along their planet, searching for food. The flying implementation follows an adaptation of Reynold’s flocking algorithm [12]. Our implementation includes constraints to avoid the viewer that takes into consideration their energy levels as well as the locations of plants as they tend to get closer to plants when below a certain energy level (The weight of this clause increases proportionally with the hunger they have, which is reflected by their reduced energy level). Crystals have the peculiarity of rapidly increasing and decreasing in size during feeding.

Other Birds’ common features and rules are: i) each family has a distinctive sound which is less intense as the distance to the viewer augments; ii) their life expectancy is pre-set and inherited from their parents; iii) and when the system is running low on memory they consume ten times more energy than usual.

III. MOTIVATIONS

In contemporary digital culture, the social status of the computer has risen as a response to the development of its performance. The computer has gained in the last decade a growing influence in a social context where audio-visual information is privileged rather than other senses. However, this increasing influence is prompting, according to authors such as Baudrillard, a new sociological phenomenon: an audience that is absently absorbed into the screens, loosing their own image [2].

With xTNZ, our aim was to produce an artwork using the techniques available on personal computers such as Artificial Life and 3D, while addressing an artistic comment on the cultural context of a spreading dependency on computers and videogames. The initial concept was the duality inside/outside offered by computer technologies when the user interacts with extended realities. The world we have chosen to represent this extended reality is a symbolic three-dimensional world with living creatures in a utopian ecosystem. We have implemented the basic behaviors of natural life such as breeding, reproducing and dying. Operating as a world, with living entities and that can be visited; this metaphor put emphasis on the duality we have mentioned.

The second main concept inspiring this system was xTNZ as an autonomous “living” entity with human origin. At the same time emphasize the concept of disembodiment. To illustrate and ironically accentuate this idea, the “living” entities initially have human sounds and are visually represented with images from human body organic tissues. Their audio and visual representation changes in time as their evolution is determined by their autonomous interactions.

IV. RELATED WORK

In the significant review of artificial life artwork, Metacreations, Whitelaw [13] suggests two categories to classify work in the field of computational aesthetic discovery in evolutionary art: Breeders and Cybernatures. With Breeders this author comprehends the work using aesthetic selection. This technique involves computational variation of images, and the use of a fittest function to evaluate the “best” phenotype. In the seminal works of Sims [4], Todd & Latham [5] and Rooke [3], the viewer performs this function when deciding which will be the next genotype. Sims and Rooke explore mathematical functions to produce the imagery. On the other hand, Latham uses a library of morphogenetic forms. More recently, this author extended the biological analogy to the
uses of encoded DNA strands translated to visual shapes through a biomorphic visual grammar [8].

The Cybernatures category comprehends the “construction of complex environments somehow simulating natural-life processes”. Here, the interactivity is usually active, as in Sommerer’s “A-Volve” [7], when the visitor can design and introduce new creatures to the world or more in the sense of participative agency as in McCormack’s “Eden” [6], where the creatures perform an improved singing to attract visitors’ attention.

V. CONCLUSIONS

This simplistic Darwinian simulation evokes nature in our most sophisticated medium: the computer. We tried to implement aspects of Darwinian theory such as competition, and resource scarcity.

This work was developed primarily with an artistic intention. In this sense, its exhibition in other contexts rather than technological have witnessed the validity and relevance of this proposition.

However, these kinds of simulations can be important in the field of ecology. Two models of genomic diffusion were explored: in xTNZ i) Birds operate in a family cumulative process acting as a whole in trying to perpetuate the family phenotype, and ii) Plants simulate more realistically the evolutionary processes, they have individual properties and we can trace back the lineage of the individuals’ pedigree.

Future developments include the implementation of these two models in the same species. Also we plan to introduce more species and change the status of currently constant variables such as mating range into dynamic. We had to constrain the size of Plants and the size of the population of Birds to prevent an easier crash of the system, due to a lack of memory; we also plan to review this situation in the future.

REFERENCES