The Cybernetic Aquarium: Explication

Introduction

A traditional household aquarium is a microcosm of an alien world encapsulated in our daily lives, ideally providing a mix of tranquility and fascination. The cybernetic aquarium uses the aquarium motif to explore an equally alien world, an abstract cosmos of algorithms, and mathematical objects and processes. It uses primitive graphic elements - points, lines, and circles - with some fundamental principles and algorithms to create a life-like ecosystem.

Design Principles

Self-assembly

The current view of the origin of life is that over eons simple molecules spontaneously formed into long chains (thanks to linking properties of carbon atoms), incubated by a watery environment and an energy source, possibly lightning, the Sun, or hydrothermal vents. These complex molecules eventually became animated and self-replicating. In the cybernetic aquarium, dots and lines symbolize this process in a very simple way - basic graphic elements connect up to become complex animated molecules. The energy source in this modern age, of course, comes from a wall socket.

Survival

In the wild, living beings compete for resources to be allowed the privilege of reproducing their kind. The creatures in the cybernetic aquarium exist only at the pleasure of the viewer, so survival for them is a matter of staying interesting. Some criteria for their survival are:

- Motion - a creature that doesn't move at all is not very interesting
- Visibility - a creature that moves risks falling off the screen at some point
- Interaction - an ecosystem as a whole is more interesting if creatures interact with each other in some way. If that interaction includes clustering together, it lessens the risk of an individual creature falling off the screen and becoming invisible, which equates to death.

Life-like behavior

Life-like behavior falls between being overly structured (behavior that repeats itself in a predictable way) and too random (behavior that has no detectable pattern at all). The Cybernetic Aquarium uses algorithms to simulate that behavior, which, ideally, would never repeat, but would also have a recognizable pattern. When dots (which are random) and lines (which are predictable) combine, the resultant behavior is complex enough to be unpredictable. Similarly, the colored circles interact in a way that is not random, but the result is sufficiently complex so as to be essentially unpredictable. This gives us the desired mix of tranquility (pattern) and fascination (unpredictability)

Aesthetics

The Cybernetic Aquarium is an art project that uses and references mathematical and scientific principles, rather than a research project that advances the state of knowledge. The environment of this manifested world is a flat screen with an array of pixels - two million glowing colored points in an area somewhat larger than the front view of the ten-gallon aquarium which serves as its conceptual model.

The static components of the visual environment are intended to create a familiar, but not literal, evocation of an underwater scene: a gradated aqua color, some dramatic underwater mounts reminiscent of viewing stones, and, in the background, a few stately artfish (based on Paul Klee paintings), traversing a leisurely sine wave. Just as a landscape painting takes natural elements and transforms them through paint, so here the vision of life in primitive seas is created using the medium of a computer language.

User interaction

The user's main role is to set the process in motion and watch it unfold, providing a reason for the existence of the creatures. You can reset the environment back to its original state where the lines and circles are as yet unconnected. You can also select a view where the background of the animation is not redrawn. This view results in a very different feeling. The aquatic tranquility is replaced by a sort of scaly worm grotto that twists and writhes with a demonic force. This view was not planned, but was discovered by accident when the background was not redrawn. It may be considered symbolic of the less savory aspects of nature that get edited out when we invite her into our homes.

Aquarium Ecology

Basic elements

A graphic system consists of some basic visual elements, such as points, lines, circles, and color. A point is simply a location in a coordinate system. A line connects two points and so has one dimension; its properties are its length and the angle at which it lies. A circle exists on a two-dimensional plane with a location and a size. Unlike points and lines, circles have an inside and an outside, which can have an additional property such as color. Circles and lines also have a symbolic function in that they represent the most elementary of particles in the cybernetic universe: zero and one, respectively.

These graphic elements inspired the four species in the aquarium: dots, lines, circles, and eyeballs. Dots, shown as tiny circles, jiggle randomly. Lines move straight ahead, swaying rhythmically as they go, bouncing off the edge. Translucent colored circles pulse and lazily pursue each other. A black circle inside of a white one becomes, in our anthropomorphic gaze, an eye, or even a conscious observer.

Dots

Dots are all the same size and are born in a random place. With each tick of time, a dot moves to a different location, a random distance and direction away. It usually ends up close by, but occasionally far away (using a mathematically defined distribution common in the natural world)[1]. The overall effect is similar to the constant thermal jitter of atoms in the physical world. This motion mostly keeps the dots on screen and thus alive, but occasionally they pop over the edge and die. The universe notices this and replaces each deceased dot with a new one at a random location on the screen.

Lines

Lines, unsurprisingly, are one-dimensional and deterministic. Once created, at a random location and with a random direction, they travel in their birth direction with Newtonian precision until they come to the edge of their world. At that point, they rebound off the edge at a mathematically precise angle. To compensate somewhat for their dull personalities, they wag their tails as they move (albeit in a predictable way). The swaying rhythm echoes the various periodic oscillations found in nature. Since

lines are aware of the edges of their world, and are programmed to stay within them, they stay alive indefinitely.

Eyeballs

The swimming eyeballs are the species closest to sentience in this cybernetic world. They consist of two circles of constant size, a larger white one that encloses a smaller black one. An eyeball's motion is semi-random, using an algorithm that simulates natural motion[2]. Each one has a special sense organ that detects whether another creature is within range, and moves the inner circle in that direction. This action gives the viewer the idea that the eyeball is in fact an observer, probably with both intent and sentience. This provides a creature for the human observer for the viewer to relate to.

The elite eyeballs are immortal. They move offscreen and back on again with impunity, as their relatively sophisticated algorithm tends to bring them back onto the screen.

Animated molecules

When these elementary particles get close to each other, they hook up to form animated molecules.

Dots do more than just jitter. If, in their jumps, they come close to a line, they will attach themselves to its tail and ride along. Likewise, if a line detects that it is near a dot, the line will adhere its front end to the dot. These points of contact may already be incorporated into a molecule, so the result is a branched, colonial animalcule that humps and writhes its way along in an endlessly varied jiggly dance.

Eyeballs participate in this madness, but only as single attachment sites, and only for lines. Their place at the top of the tiny Chain of Being in this world precludes them from having to attach to others. One can attribute a sort of pride to them, but eyeballs are masters at fooling the viewer into thinking that they have more going on than they actually do.

Circles

Translucent colored circles pulsate and drift to their own rhythm and do not interact with the other species in the aquarium. Each circle moves toward another which in turn is moving toward yet another[3]. Circles take advantage of their two-dimensional nature to add color and rhythm to their world, like butterflies, birds, or jellyfish do in ours. Circles are grow to predetermined size and simply pulsate lazily thereafter. Their insides are filled with a random translucent color. When they cross each other, a third color is formed in the overlapping *vesica piscis*.

Circles ignore the compounding process that the other creatures engage in. They spend their time interacting with each other, slowly and gracefully. Each circle is aware of the location of the others and heads toward the nearest one (provided that one is not heading toward it). Since that circle is itself on its way to another circle,

Circles are unaware of the Edge, so they can potentially fall off, and, like the dots, be replaced. The universe collects the souls of departed circles and releases them back into the world on occasion.

Technical Data and Footnotes

The Cybernetic Aquarium is an example of generative animation. What the viewer sees is not a movie that repeats in a loop; each frame of the aquarium is created in real time.

The software was uses Processing 3.0, an animation-friendly front end to Java. More information on Processing can be found at processing.org

The hardware is a Mac Mini with 8 G of RAM and a 23" Acer monitor

1. Dot motion uses the random Gaussian function found in Processing

2. Eyeball motion uses an algorithm based on Perlin noise, also built into Processing

3. The circle motion algorithm is home-brewed and was inspired by the three-body problem, where the motion of three gravitational bodies orbiting each other becomes chaotic and so ever-changing, and flocking algorithms, which use simple rules to create complex behavior. The rules for the circles are:

Pursue the closest circle that is not itself or one pursuing it
Chart a course partway between a circle's innate direction and heading toward the closest circle
Keep a minimum distance away from the pursued circle (avoid getting stuck together)

The Cybernetic Aquarium was developed by Jim Stewart, curator of the Zymoglyphic Museum. For more information, please visit zymoglyphic.org/genart.html or contact zymoglyphic@gmail.com