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Mutator VR: Vortex Artwork and Science Pedagogy Adaptations

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Abstract

We present our virtual reality artwork Mutator VR: Vortex *that immerses the viewer in procedurally-generated alien environments inhabited by interactive "mutoid" agents. The artwork was adapted into two science pedagogy experiences. Techniques and considerations regarding the dynamical, spatial, and graphical composition of the experiences are provided.*

CCS Concepts
• ***Computing methodologies*** → *Procedural animation; Virtual reality; Parametric curve and surface models;* • ***Applied computing*** → *Interactive learning environments; Media arts;*

1. Introduction

Mutator VR: Vortex is a virtual reality (VR) artwork that immerses the viewer in procedurally-generated, abstract alien worlds with interactive agents we call "mutoids." The work is a continuation of earlier work in computer-generated organic forms [TL92] with increased emphasis on immersive environments. An important element across the lineage of work is invoking in the viewer a sense of *discovery*. We draw artistic influence from science fiction and fantasy art, futurism, and surrealism and from specific artworks such as Ben Laposky's *Oscillon* oscillographs [Lap69], Karl Sims' *Particle Dreams* (1988), Char Davies' *Osmose* (1995), Marcos Novak's *Eduction: The Alien Within* (2001) and David Em's *Vascula* (2015). *Mutator VR: Vortex* has been shown at numerous exhibitions including *New Scientist Live* in London, *Cyfest 11* in St. Petersburg, *Hybris* at Ca' Foscari University of Venice, the 2017 Ars Electronica *Gallery Spaces* and *Pendora Vinci* at the NRW Forum in Dusseldorf.

2. Technical Overview

We give a brief overview of the composition of the work here; more details may be found elsewhere [PLT17]. The hardware used is an HTC Vive room-scale VR system and PC with an Nvidia GTX 1080 GPU. Custom software is written in C++/OpenGL using the AlloSystem, Gamma, and OpenVR libraries. Agent dynamics follow a basic Newtonian particle system [Ree83] with parallel transport [HM95] used to generate well-behaved orientation frames for rendering agent bodies. Autonomous agent motion is accomplished through spatially-distributed gravitational sinks. Pressing a controller trigger creates a long-ranged gravitational sink at its tip that attracts the agents. Agents contain internal "friendliness" clocks so that only a portion of the agents respond to interaction at a given time. This prevents excessive clustering

near the user and adds interest over time as a diversity of agents enter and exit the sphere of interactivity.

All structures and entities in the virtual world are constructed from linear combinations of Clelia [Gra28] and related "Euler" [Put14] spherical curves. The curves generate an endless array of rich, organic results, yet are non-figurative facilitating our goal of creating believable, yet otherworldly worlds. The curves are procedurally textured, bump mapped and modulated along their length between two sets of material parameters to provide dramatic lighting effects and heighten realism. Each world consists of two extensive curves filling a 32-meter diameter "world" sphere. These curves create an environmental backdrop to situate the agents and help promote exploration of the space. On the boundary of the world sphere is an exoshell produced from a relatively dense spherical curve. The exoshell provides additional visual interest as well as parallax depth cues for the interior structures. The mutoid bodies are generated from random families of curves, but constrained to have bilateral and radial symmetry as these symmetries are prevalent in living organisms. Figure 1a shows the described components.

3. Science Pedagogy Adaptations

Mutator VR: Vortex was adapted to two interactive science pedagogy experiences intended for all age groups. The first of these, *Cell Flows*, is an artistic representation of a tumour microenvironment done in collaboration with scientists from the Francis Crick Institute in London. The work was shown at the *Crick Late* and *Crick Discovery Day* events in spring and summer of 2018. In this experience, viewers encounter a tumour site surrounded by cancer cells and a type of blood cell called a fibroblast. Emanating from the tumour site are collagen fibers produced by the fibroblasts. Evidence suggests that cancer cells can

"hijack" fibroblasts through chemical signalling to lay down tracks that they then use for transport to other parts of the body. The user is allowed to disrupt this signalling mechanism through a controller press. Figure 1b shows an image from the VR experience. The large spherical structure on the left is the tumour site and the smaller colored objects on the right represent cancer cells. The lemon-shaped objects between the tumour and cancer cells represent fibroblasts. The fibroblast trajectories follow a predetermined canal curve [Mon50] to imitate the flocking dynamics observed in real cells. This is done, rather than a simulation, to allow precise control over the grouping, timing and trajectory shape of the fibroblast flocks. The second pedagogical experience, *Jellyfishin' VR*, immerses the viewer in an underwater environment where they can approach talking jellyfish to hear ecological facts (Figure 1c). The work was shown as part of the *Welcome to the Bloom* exhibit at the 2018 York Festival of Ideas. The jellyfish are generated from closed curves with a mushroom shaped envelope. The curve is cut opposite the bell to produce trailing tentacles. To emulate the pulsating body contortion jellyfish use for locomotion, travelling waves are imposed on the curve that propagate along the central axis and with increasing displacement from the bell to the tail. Initially, some children were afraid of the experience; lowering the jellyfish below eye level appeared to help mitigate this.

Acknowledgements

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(a)
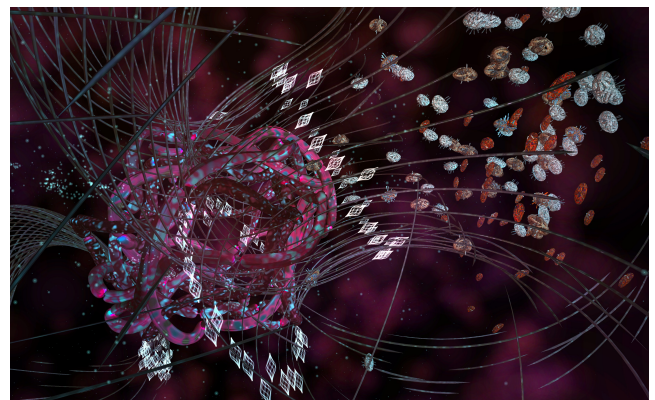
(b)
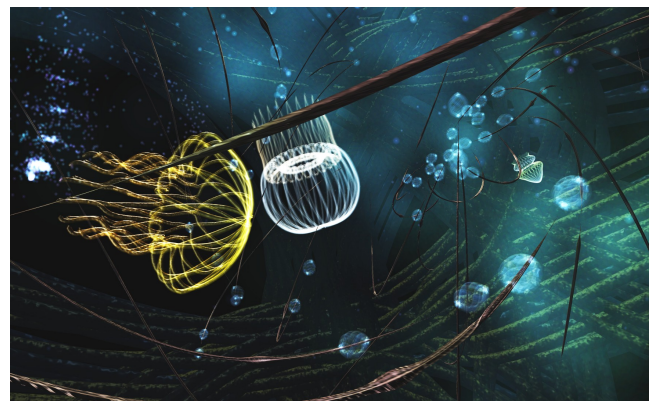
(c)

Figure 1: Interactive virtual reality worlds constructed entirely from linear combinations of spherical curves: (a) *Mutator VR: Vortex* immerses one in shape-shifting alien environments with vine-like structures and interactive "mutoid" agents, (b) *Cell Flows* is an artistic representation of a tumour microenvironment that lets the viewer interrupt adverse signalling behavior from cancerous to healthy blood cells and (c) *Jellyfishin' VR* is a deep sea experience that lets one learn ecological facts by approaching talking jellyfish.