Abstract

Smoke Water Fire (2016) is a digital video for stereoscopic virtual reality systems. It is a radiosity rendered computer simulation of the collision of many fluid volumes, and required 8 months to generate. Instead of the forms being rendered as a natural material, though, they are presented in their pure, computational form. By stripping the fluid of its physical context, it can exist in a purely ephemeral, numerical, virtual state.

Keywords: algorithmic art, contemporary art, generative art, computational physics, fluid dynamics, virtual reality

Index Terms: J.5 [Computer Applications]: Arts and Humanities—Fine Arts; I.3.7 [Computing Methodologies]: Computer Graphics—Three-Dimensional Graphics and Realism—Virtual Reality

1 Statement

My artwork is very process-intensive, and involves highly-computational explorations of the patterns of nature. I leverage science and technology to explore the intersection of the seemingly-opposing paradigms of physical and virtual worlds, of fluid and solid, matter and information, and life and algorithm. Much of my work has been focused on fluids, which I see as the most dynamic and ephemeral of natural media. By working with virtual representations of these processes, the ephemeral can then be made timeless, the fluid solid, matter represented as information, and a physical moment exposed to virtual exploration. Surprisingly the algorithms I use mimic the natural processes themselves, so natural and virtual worlds are now connected by the fact that they are both driven by complex, non-linear, highly-interacting, generative behavior.

2 Process

The process to create Smoke Water Fire began with the development of a novel system for simulating turbulent flows: a front-tracking vortex method [1]. This technique tracks only deformable surfaces on which density or velocity discontinuities exist. It is not only natural to visualize results from such a method by rendering the surface alone, but also much easier than traditional volume visualization. The numerical method, by its use of vorticity variables, satisfies continuity, reducing numerical diffusion and allowing large time steps. This makes the method suitable for running complex flows on commodity desktop and laptop computers.

The simulation that generated the geometry had, as its initial condition, one sphere at the center of gravity surrounded by a fluid of lower density. Multiple smaller spheres of varying sizes and densities are then created outside of this sphere and drop into it. The density difference between the fluids drives the dynamics.

Radiance [2] was used to render the frames, which consisted only of the mesh edges and two light sources. 7225 frames were generated in full HDR at 11520×11520 resolution using a multiple-bounce stochastic radiosity method on a single 8-core workstation over the course of 2016. Mencoder rescaled and assembled the final video.

Acknowledgements

Original research on the numerical method was supported in part by a grant from Chevron Corporation.

References