Image Based Fluids

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1. Abstract

Characters and objects that are touched by fluids need to look wet. Their Interaction with the fluid needs to be exciting as well as convincing. The complexities of 3D fluid simulation techniques normally used to achieve this in CG animation are often time consuming and difficult to control.

Using image-based fluid simulation enabled more precise art direction which allowed us to achieve our goal of realistic, believable fluid interaction between characters and their environments.

This sketch describes the variety of image-based techniques used for several shots in the animated feature *Shrek 2*.

2. Control, Speed, and Flexibility

Achieving the look of 3D fluid motion using image-based methods requires the FX animator to create specific simulations for each element in a shot. This method minimizes the common "wild card" of simulated FX – controlling and keeping track of the large number of variables required of a complex 3D simulation. Instead, by breaking the effect into smaller pieces that can be developed in parallel, the FX artist can use multiple techniques to generate source fluid motion textures including: painted textures, 2D/3D paint, procedural 2D texture maps, 2D/3D fluid simulators, as well as traditional particle simulation.

3. Surfaces and Height Fields

The primary concern in a fluid simulation is the surface of the fluid. Rather than simulating a full body of water, we focus on the water surface. To achieve this, the simulation is rendered from a top down camera as a 2D height field used to displace the primary surface.

Layers of complexity can be added on top of this base simulation with additional mini simulations. It was difficult to achieve good fluid motion on various parts of one of the characters who gets submerged in fluid, so we ran smaller simulations and then composited those elements into the final texture maps.
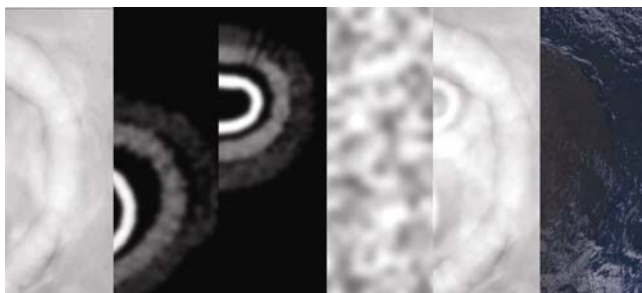

Fig. 1 *Element progression and final rendered image.*

Additionally, FX artists can directly manipulate the image maps. 2D warping is useful to reposition or tweak motion. Painting and procedural noise are used to add detail to very specific parts of the surface.

4. Splashes and Getting Wet

We relied heavily on the use of texture maps for splashes caused by explosions. We filmed live action reference, then painted and animated spray patterns. Further complexity was painted on the animated textures to convey the feel of absorbing water.

With a locked camera or a static object, we rendered the fluid/object intersections with a fluid surface and then ran an accumulation algorithm to represent the water contact with the element surface. With a moving camera and/or characters, maps had to be generated to query the closest point or a derivative particle set on the surface of the character. These techniques combined with painted textures created convincing results.

5. Deforming Surface Interaction

The steam and bubble effect on the surface of mud were instances of surface interaction. We queried the offset of the mud surface in a displacement map and converted the xy coordinates into displacement uv space.

Similarly, we triggered popping bubbles on the surface of a liquid. Here, we tied the event to a particle system that emits a ripple.

Fig. 2 *Mud bath and bubbles*

These particles are mapped with specific patterns to match the size, shape, and behavior of each bubble explosion. Rendered as cards, they are composited back into the original height field.

6. Credits

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