Real-Time Fluid Simulation Using CUDA

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Abstract

We intend to develop an NVIDIA CUDA application for simulating and rendering fluids in real time. The user will be able to interact with the fluids at will. An example of our intended result (although perhaps not as sophisticated) is the NVIDIA FleX library, which uses unified particles. The focus of our project will be on liquid fluids, but if time allows we will expand to other materials.

Techniques

The fluid representation we will be using is Smoothed Particle Hydrodynamics. It represents fluids as a collection or particles. Attributes of the fluid (viscosity, density, etc.) at any point in space are defined using a kernel function to average nearby particles. We will superimpose a uniform grid on the simulation to facilitate faster particle nearest neighbor calculations. An additional optimization we will be using is the so-called “tall cell” method. Fluid particles below the surface will be simplified into a single “tall-cell” to simplify calculations further.

Technologies and Libraries

CUDA will be used to simulate the particle flows using Smooth Particle Hydrodynamics, as well as construct the mesh from a scalar field using marching cubes. The rendering will be handled by OpenGL. The windowing library will be GLFW. Additional libraries include GLEW (GL Extension Wrangler) for accessing OpenGL extensions. There is a possibility that we will be using the Thrust Library.