CIS 563: Physically Based Animation
Final Project Assignment
Fluid Simulator

Due: Sunday May 6th, 2018

Introduction

In this assignment you are tasked with writing a smoke simulator using the smoke simulation paper, *Visual Simulation of Smoke* (Fedkiw et al., link). This paper should be everything you need to properly simulate smoke, especially paired with all that you learned in implementing a solid simulator. This should be an easier project overall and you have built many of the skills necessary to do this while working on your solid simulator. As such, we would like you to complete this project **by yourself**. To make this more manageable, we will be releasing some base code to get you started. You may use the base code as much or as little as you would like.

Requirements

1. Eulerian grid-based 3D smoke simulator (as outlined in the Fedkiw paper)
   a. NOTE: you should be able to prove that your method maintains divergence free velocity fields throughout simulation.
2. A way to visualize the smoke in 3D (see the visualization section)
3. Three interesting demos showing off your simulator!
   a. Examples: simple rising smoke, two smoke sources injecting towards one another, smoke propagating through a complex space, smoke with different properties, etc.

Visualization

The base code we are releasing renders the density field using OpenGL to give a rough (and somewhat boring) 3D visualization of the smoke propagating through a small space. However, we would like you to choose some way to extend this visualization to be more interesting! There are two main approaches to this:

1. Rendering based on the density field (Example in 2D: link)
   a. There is no need for OpenVDB to do volume rendering anymore! All you need to do is to output the density value at each cell's center as a .bgeo file, and we will provide corresponding Houdini file to help you render it.
2. Adding particles to your simulation, letting them advect along the velocity field, and then rendering particle frames. The basecode we are releasing has this capability! (Example: link)

You may use any approach you like but we want you to take this opportunity to make your simulation really stand out! Be creative, use color, and make something awesome for your demo reel! Your videos can be visualized any way (Houdini, openGL, your own visualization tool, etc.) as long as you can make cool smoke videos!

Helpful References

- Seminal work on smoke simulation: *Visual Simulation of Smoke*, link
- Seminal work on fluid simulation: *Stable Fluids*, link
- SIGGRAPH 2007 Fluid Simulation Course Notes, link

Extra Credit

There are no explicit point values set aside for extra credit. That said, we **will** hold projects that go above and beyond in higher regard when grading and it can easily bump you up a portion of a grade. Some possible extra credit extensions could include:

- Awesome smoke visualization/rendering
- Cool and unique demos
- Extending your smoke simulation itself (look at Siggraph papers like *Schrodinger's Smoke* for inspiration!)
- Augmenting the smoke sim to try and simulate fire
- Implement a liquid method for water simulation (FLIP, or PBF are good targets!)
    - For FLIP : https://www.cs.ubc.ca/~rbridson/docs/zhu-siggraph05-sandfluid.pdf
    - For PBF: http://mmacklin.com/pbf_sig_preprint.pdf

Presentations

There will be **no presentations** this time around so you can focus on polishing your sims and getting good videos for submission!

Submission

1. 2-page (minimum) **LaTeX writeup (as a PDF)** of:
    a. What you implemented and how you did it
    b. 3 or more video clips as YouTube link(s) **in your writeup** showing three different configurations or interactive features. As before, these demo videos are your chance to show off your solution and your creativity; good demos are integral to the field of simulation, and are a great opportunity for demo reel clips.
2. Your code base as a compressed .zip file