Project 5: Fun with fluid

Due: Oct 29, 2018, 11:55PM

Let's build a fluid simulator! Your job is to create 2D smoke fluid simulation using a grid-based, Eularian approach. Your velocity field and density field must obey Navior-Stoke equations, incompressibility, and boundary conditions. The simulator must be interactive and run in real-time; the user can use a mouse to manipulate velocity and density fields and visualize the smoke evolving in the 2D grid in real-time. The skeleton code provides a pretty good starting point for you. It includes basic UI and mouse interaction code, as well as the data structures and major procedures required to simulate 2D fluids. In particular, the code for evolution of density field includes all three steps: adding density, diffusion, and advection. However, the code for evolution of velocity field is incomplete, as you can see that the smoke stays stationary in the current skeleton code. You will develop code for velocity advection and projection to move the smoke around accurately. Specifically, your task is to

1) develop a procedure to advect the velocity field using semi-Lagrange method
2) develop a procedure to project the velocity field such that incompressibility and boundary conditions are satisfied.
3) Create a colorful smoke simulator by using three density fields, each of which stores the density of a color channel (e.g. Red, Green, Blue).

Skeleton code

Download the following skeleton code. You don't need DART for this project. The two functions you need to complete are MyWorld::advectVelocity and MyWorld::project.

UI control provided by the skeleton code:

1. Left click and drag: add density
2. Right click and drag: add velocity
3. 'v': Visualizing velocity/density
4. Space bar: simulation on/off

Extra points:

1. Implement code to load in an initial density field described as an image (grayscale of RGB). e.g. You can load in a picture of Mona Lisa and blow it away (2 points).
2. Add arbitrary boundary in the grid. e.g. Create a "C" shape in the middle of the grid to see how it affects the smoke (3 points) .
3. Add external forces to the velocity field. e.g. Mimic the effect of a fan in the middle of the grid (2 points).