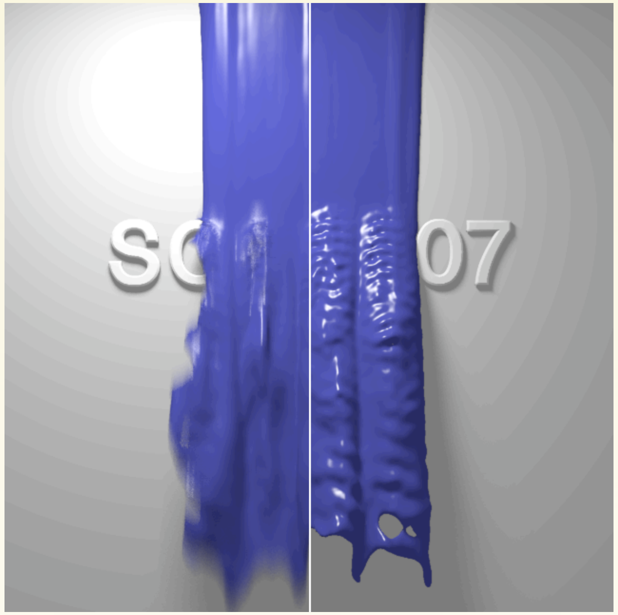
Eulerian Motion Blur



A motion blurred image (left) produced with the Eulerian motion blur and an un-blurred image (right)

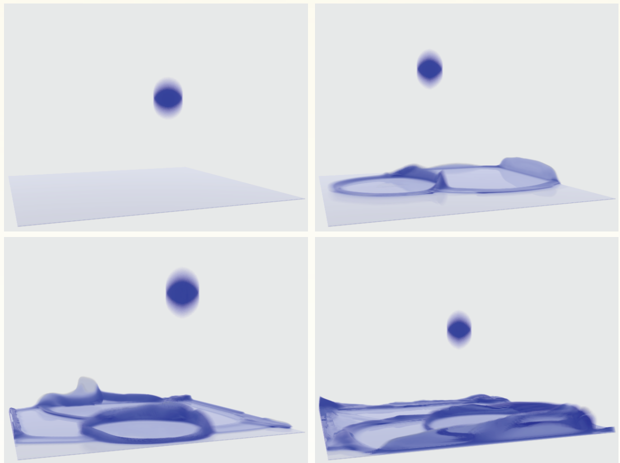
Introduction

This poster describes a motion blur technique which can be applied to rendering fluid simulations that are carried out in the Eulerian framework. Existing motion blur techniques can be applied to rigid bodies, deformable solids, clothes, and several other kinds of objects, and produce satisfactory results. As there is no reason to discriminate fluids from the above objects, one may consider applying an existing motion blur technique to render fluids. However, the existing motion blur techniques are not suited to Eulerian simulations. So, we propose a new motion blur technique that is suitable for rendering Eulerian simulations.

Proposed Method

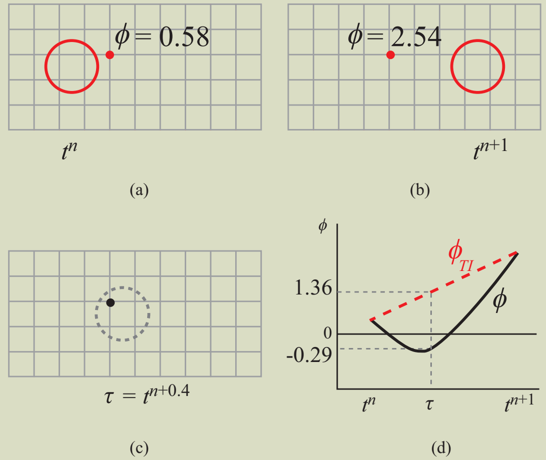
In developing Eulerian motion blur, we assume that the simulation result for each frame is given in the form of 3D grid data. The grid data consists of the level-set (or density) and velocity fields. It is necessary to know how a ray traverses the fluid at an arbitrary super-sampled instant. The required information is the level-set (in the case of water) or density (in the case of smoke) values at the cell corners of all the cells the ray passes.

We propose that the estimation of the level-set values at arbitrary super-sampled instants be based on the level-set advection, rather than the time-interpolation of the level-set values. More specifically, we propose to estimate the level set value at a 3D position, at a super-sampled time with the semi-Lagrangian advection. The velocity also can be estimated with another advection.



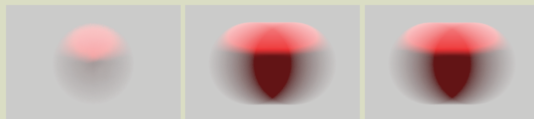
Sequence of images taken from the simulation in which chunks of water are dropped onto shallow water.

Why Time-Interpolation Does Not Work



For the motion blur, we must somehow estimate the level-set values at arbitrary time sample. For the estimation, Enright et al. [2002] presented a method which interpolates the level-set data between two frames.

Contrary to expectation, the above estimation gives incorrect results. Imagine the simple case shown in the figure above, in which a spherical ball of water is making a pure translational movement along the horizontal direction at a constant velocity. The time-interpolated value is pretty much far from the expectation, even for the simple situations.



(a) (b) (c)

(a) Motion blur with time-interpolation, (b) motion blur with Eulerian motion blur, (c) the ground truth.