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Energy

Developing Level Set Solver for Use in a Cartesian Cut Cell Segregated Flow Solver

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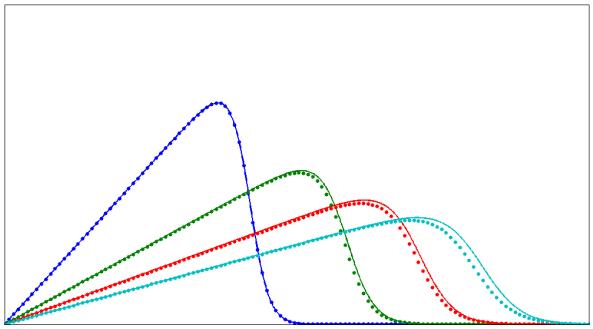
A breaking wave simulated on computer

Taken from work by Prof. M. Sussman
http://www.math.fsu.edu/~sussman/

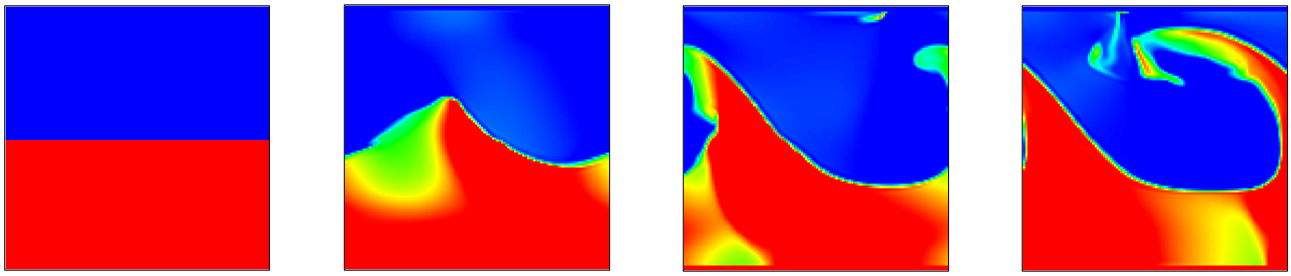
The study of segregated fluid flows on digital computer has progressed steadily for the last 50 years. Despite many advances, scientists and engineers still have many challenges to overcome. One such challenge is accurate, efficient simulation of breaking waves. The goal of this PhD project is to implement a level set free surface tracking method in a segregated Cartesian cut cell solver. The result will be a robust solver capable of simulating wave break-up. This will provide researchers with more methods with which to analyse breaking wave action on both renewable energy devices and coastal defence structures.

The CIP (cubic interpolated propagation) method is used to solve the hyperbolic parts of the Navier-Stokes equations. This will form the basis of an incompressible flow solver. To the left is a diagram of a 1D Burger's equation problem. The problem is similar to the Navier-Stokes equations in 2D. The function is advected from left to right as it progresses diffusion reduces the slope of the function. Below is a example of the incompressible Navier Stokes equations acting on two fluids of different density. This example has no surface tracking method the stop the fluids from mixing over time.



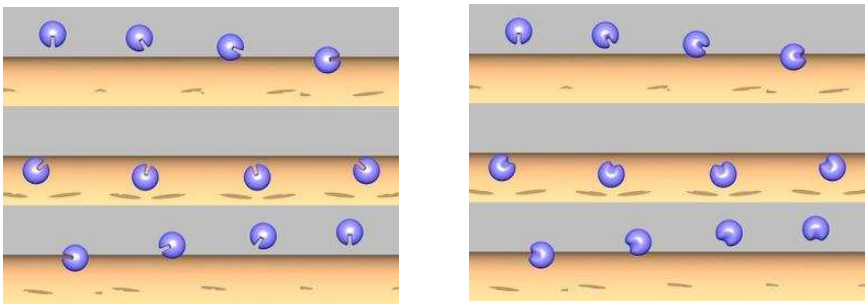
The Burger's equation progressing with time from left to right

Analytical solutions solid line/ Approximated numerical solutions dotted



Simulation results of the Rayleigh-Taylor instability problem

Results provided by Dr. D. Ingram, The University of Edinburgh



'Zalesak's disk' with free surface tracking by the level set and particle level set methods respectively

Taken from work by Prof. R. Fedkiw http://physbam.stanford.edu/~fedkiw/

The level set method is to be used to track the water/ air interface in multifluid problems. The figures to the left show a comparison of the level set and reinitialised level set methods preserving the free surface of 'Zalesak's disk' when rotated through 360°. The particle level set method preserves the sharp slot feature of the disk where the simple level set method fails.

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