2017 ACCES Visualization Contest - Example C

Entry title: *The Rayleigh-Taylor instability rediscovered*

Group members: *Student A (simulation), Student B (visualization)*

Category: *Static*

Computational Thinking

Modern scientific discovery can often mirror ancient culture in its form or resemblance. The visual representation developed for the present entry situates a fluid instability described by eminent British scientists, Lord Rayleigh (1883) and Sir Geoffrey Taylor (1950), in ancient Greek times. The periodic form of the unstable interface between two immiscible fluids of different densities is adapted to the frieze of an ancient Greek pot ready to be rediscovered. In fact, the black figure artistic style, a Corinthian invention of the 7th century BC, provides an aesthetic means to convey the intemporal nature of science.

Concept composition

The concept underlying the present entry is composed of three main parts: the numerical simulation of the Rayleigh-Taylor instability, the construction of an image of the periodic unstable interface, and the use of this image as a template for the circumferential frieze of an ancient Greek pot.

Flow simulation

The Rayleigh-Taylor instability occurs at the interface between a light fluid on which is placed a denser fluid. It can be numerically simulated by solving the two-dimensional Navier-Stokes equations for the time dependence of the position of the initially flat horizontal surface between the two immiscible fluids. The present results were obtained using the freeware *Gerris* software (http://gfs.sourceforge.net).

Topology

The interface between the two fluids is computed using the volume-of-fluid (VOF) method and determining where the volume fraction of both fluids is 0.5. This interface becomes increasingly complex as the fluid instability grows, and develops from an initially flat line into complicated mushroom-shaped curves. Examples shapes are presented for 5 times in the upper part of the visual representation.

Visualization

The fourth image is periodically reproduced in the cross-flow direction to form the template for a "Rayleigh-Taylor frieze" on a pot-shaped virtual geometry. The construction was performed entirely using *Google SketchUp*. The pot shape was chosen from the internal "3D Warehouse". The frieze image is then texture-mapped onto the pot surface. A scene is then composed, containing two pots (a pot lying on its side with a classical Greek black-figure frieze, and a standing pot with the Rayleigh-Taylor frieze), a tiled floor surface and back lighting.