REAL-TIME CONTROL AND STOPPING OF FLUIDS

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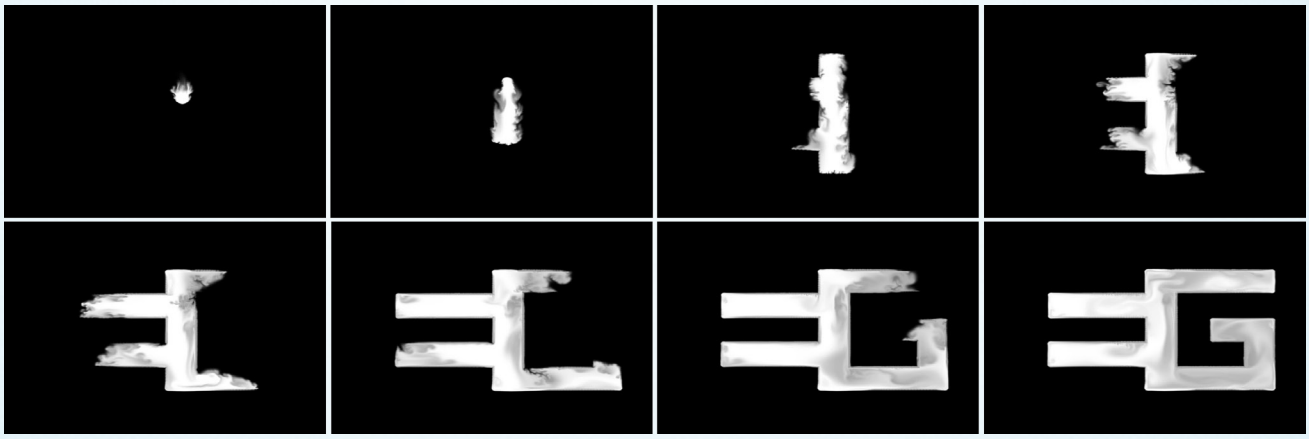
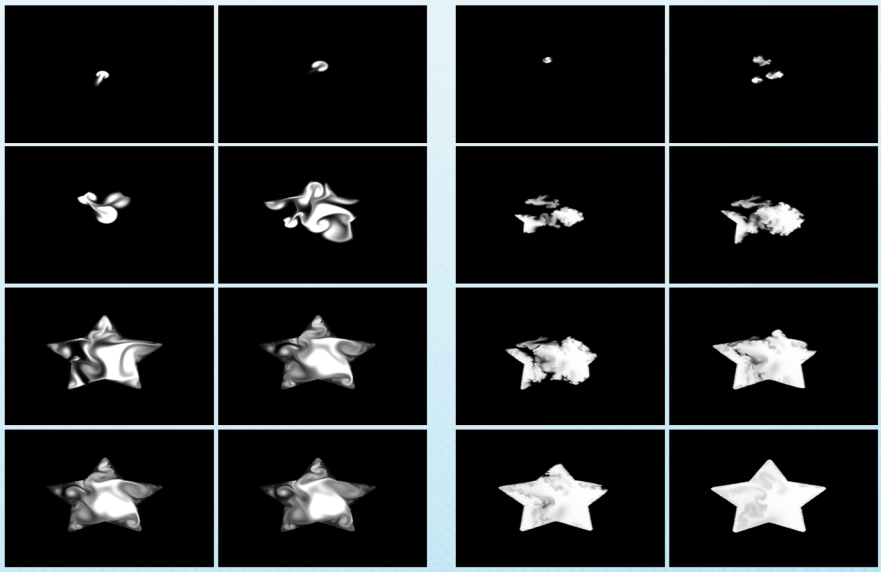


ABSTRACT

» In this paper we address the fluid control problem, where an arbitrary density distribution (a shape of any kind) is given, and forces are exerted to get the fluid to flow into this shape and stop when the target distribution is reached. We present a real-time solution.

FLUID CONTROL

» We present a novel algorithm to the fluid control problem, where an initial state and a target density distribution are given for the fluid, with the intention that it would sooner or later take the form of this distribution.
A solution to this problem is an external force field that is changing in time, describing the forces that have to be exerted on the fluid to take a given shape. A desirable external force field makes the fluid converge in a short amount of time, with the slightly ambivalent requirement of giving a realistic flow in the meantime, even if it is highly unlikely that a bowl of water would suddenly take the form of natural objects.



» *Fluid simulation without control forces, only boundary conditions are used (left). The proposed method provides good coverage of the target density, and is aware of the regions of poor convergence, which are constantly helped out by nearby regions (right).*

FLUID STOPPING

» Fluid stopping is an essential part of fluid control. When the target density is obtained, the converged state must be maintained in a natural way. The most straightforward approach to do this is to increase the viscosity, i.e. the friction to dissipate the kinetic energy and to make the fluid stop. This solution, even if simple and intuitive, makes the fluid stuck in narrow choke points, making convergence impossible, and giving highly unconvincing results in the process.

Unlike state-of-the-art methods giving convincing results at the cost of 5 to 7 minutes of computation time per frame, our method is able to solve the fluid control problem in real time and keep the fluid in motion after reaching convergence.

FUTURE WORK

» We have the simulation and control algorithm working in 2D - implementing them in 3D is required,
» Proofs are needed that the new method always provides results with a desirable degree of realism in practical cases.

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