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Crashing waves, awesome explosions, turbulent smoke and beyond: applied mathematics and scientific computing in the visual effects industry.

Whether it's an exploding fireball in "Star Wars: Episode 3", a swirling maelstrom in "Pirates of the Caribbean: At World's End", or beguiling rats turning out gourmet food in "Ratatouille", computer-generated effects have opened a whole new world of enchantment in cinema. All such effects are ultimately grounded in mathematics, which provides a critical translation from the physical world to computer simulations. We will describe some of the most compelling applications of applied math and scientific computing in the visual effects industry. Furthermore, we will discuss some of the ways in which physical simulation techniques for special effects differ from those developed for more classical applications in physics and engineering. Particularly, there are many cases where the artistic vision of a scene requires a high level of controllability in the outcome of a simulation. To this end, special effects simulation tools, while physically based, must be able to be dynamically controlled in an intuitive manner in order to ensure both believability as well as the quality of the effect. We will highlight techniques from computational fluid dynamics, computational solid dynamics, rigid body simulation, and collision detection and resolution. (Received August 18, 2010)