

Apply It.

The math behind... Special Effects



Technical terms used:

Partial differential equations, numerical algorithms, computational fluid dynamics

Uses and applications:

Over the last few decades, special effects have become an important part of Hollywood movie productions. Special effects are widely used for natural phenomena simulations such as tsunamis, tornadoes, and fire, as well as for the movement of cloth or hair in animated movies.

How it works:

When you see an awesome explosion, a building collapse, or a boat caught in a storm in a movie, the odds are that these were not actually filmed. Setting up and filming these scenes is often expensive and extremely dangerous for the people working on the set. Instead, these spectacular scenes are computer-generated images incorporated into the film post production.

All phenomena mentioned above are governed by physics and can be mathematically modeled by a system of partial differential equations. Partial differential equations can sometimes be very hard to solve exactly. That is the reason why numerical algorithms are used in order to provide approximations of the solution. The better the approximation of the solution, the more realistic the special effect will look on screen. As computers get faster, it is possible to approximate the exact solution faster and more accurately, which results in more realistic special effects.

For example, water, fire, and smoke can be modeled as fluids. Therefore, special effects simulating physical phenomena such as floods, fires, tsunamis, tornadoes, and explosions can be achieved using computational fluid dynamics, which allows filmmakers to create relatively accurate simulations of these phenomena.

Interesting fact:

Avatar, one of the most amazing films ever created in terms of special effects, had to be postponed for seven years because the technologies that James Cameron wanted to use for the film were so expensive at the time that no studio thought it would be economically viable to pick up the project.



References:

[1] A. McAdams, S. Osher and J. Teran, "Crashing Waves, Awesome Explosions, Turbulent Smoke and Beyond: Applied Mathematics and Scientific Computing in the Visual Effects Industry.", *Notices of the AMS*, 2010; 57 (5): 614-623 .

[2] The official Avatar Community. (2010). Interesting facts about the CGI used in Avatar. Online at <http://avatarblog.typepad.com/avatar-blog/2010/05/learn-about-the-different-special-effects-used-in-the-making-of-avatar-the-movie-.html> .

Submitted by Quentin Vanderlinden, Université Catholique de Louvain, Belgium
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