In pursuit of the perfectly animated cloud of smoke

March 12 2015

In pursuit of the perfectly animated cloud of smoke. Credit: T. Kim/ N. Thuerey/ M. Gross/ D. James

Simulations of impressive landscapes and alien creatures have become commonplace, especially in fantasy and science fiction films. But simulations are also appearing in ever more medical and engineering applications. However, the road to a perfect illusion is complex and time-

intensive. Nils Thürey, professor at the Technische Universität München and his colleagues have developed a methodology that could accelerate these calculations.

The attack takes place at the climax of the blockbuster "Avatar": Rockets slam into the Pandora inhabitants' homeland tree. Explosions, flames and thick clouds of smoke appear on the screen.

To keep the audience pinned to the edge of their seats the images must be realistic. But, especially the simulation of physical processes is tough to implement. This includes the representation of liquids and gasses, which fall into the category of fluids.

Rendering complex, turbulent movements is particularly difficult for programmers, explains Prof. Nils Thürey of the Department of Computer Science at TU München. "Three seconds of such a scene require hundreds of simulations, each of which often takes over ten hours of computing time."

Mimicking nature

Time that is available for large film productions. However, in computer games it becomes painfully obvious that the limits for realistic, fast and flexible simulation of fluids are quickly reached. Rapid simulation of things like air turbulence and blood is also essential in medicine and engineering.

To speed up the computational process, the scientists have gone back to the roots, so to speak. They analyze the behavior of real fluids and gasses. Obtaining data that are useful for simulation calculations from these observations required elaborate techniques in the past. In collaboration with international scientists, Thürey has now demonstrated that the data can be calculated from simple video clips. They are

presenting their methodology in the journal *ACM Transactions on Graphics*.

Autocompleting movements

The complex turbulences in phenomena like smoke are barely or not at all discernable in video images. To fill this gap the scientists once again employ simulations. Based on experience and the laws of physics, the program automatically fills in the gaps. "The brain also has this capacity," explains Thürey. "In this way individual dots on a piece of paper suddenly appear as an image, even though they are not at all connected in reality."

Using this principle, the simulation software calculates the most probable course of movements, even when this is not distinctly ascertainable from the data.

Medical diagnoses and spectacular effects

The idea is now to optimize this methodology for various applications. Simulations of blood flow in combination with computer tomography can help assess the acuteness of an aneurism. The simulation of fluids is also essential in the design of airfoils and other aerodynamic bodies. And, of course, the new programs will also improve computer games - and facilitate spectacular explosions on the screen.

More information: James Gregson, Ivo Ihrke, Nils Thuerey, Wolfgang Heidreich: From Capture to Simulation – Connecting Forward and Inverse Problems in Fluids, *ACM Transactions on Graphics* (TOG) DOI: 10.1145/2601097.2601147

Provided by Technical University Munich