Physics Based Simulation for Computer Graphics

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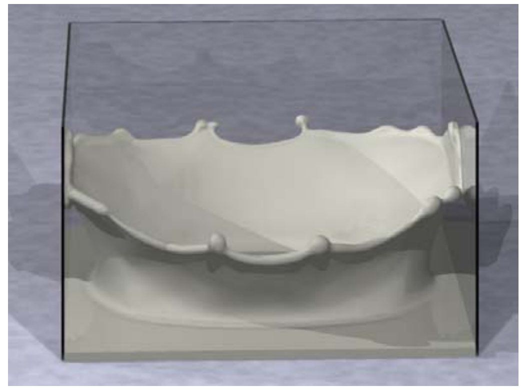

This talk will take a survey approach to physics based simulation for computer graphics. For each topic, we will discuss the basic simulation techniques emphasizing the key enabling technology that allows for high quality simulations. First, we will consider smoke simulation on both uniform and octree grids using vorticity confinement to provide for adequate rolling motions. A two-dimensional technique for simulating nuclear explosions will be discussed as well. Then we will discuss the use of level set methods for simulating water and other liquids, along with the ghost fluid method for simulating fire. Turning to the simulation of solids, we will first address mesh generation techniques for both volumetric tetrahedral meshes and for triangulated surfaces. Then rigid body simulation techniques will be discussed with an emphasis on methods for treating contact and collision between large numbers of nonconvex bodies. Next, we will consider the simulation of cloth and thin shells with an emphasis on newly proposed techniques for treating bending as well as full-proof collision techniques that stop all nonphysical interpenetrations of the thin triangulated surface. Finally, we turn to finite element simulations proposing a new technique that allows for robust simulation even under adverse conditions such as the full collapse or inversion of individual elements. Then a new discrete virtual node algorithm that provides the degrees of freedom necessary to topologically separate a mesh along arbitrary (possibly) branching curves will be presented in the context of fracture. Examples of finite element simulation include elasticity and plasticity for both shells and volumes with isotropic and anisotropic materials including both active and passive components. Time permitting, implications for simulating the human musculoskeletal system will be discussed.