Introductory Physics Based Visual Simulation

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Abstract (max 500 words)

This paper provides a succinct review of physics based visual simulations methods. It is aimed at newcomers in visual simulation in an advanced IT simulation course, including flexible learning mode. It is also intended as an inspiration for research into physically truthful visual simulation. The emphasis is on how to approach presenting visualizations of the processes modelled, which are physically correct and consistent, with minimal error. While this paper does not intend to provide a "Physics in a Nutshell" course, it merely invokes Physics in a few instances where a quick reminder is appropriate. A selection of specific cases and visual examples are discussed in this paper.Simulation methods are grouped into static and dynamic simulations, and modelling solids, liquids and gases. For example: Clouds (dust, water) for gas/static; and fire, clouds, turbulences for gas/dynamic.

At current state of the art, not all the physically possible states can be modeled and rendered into meaningful visualizations. Conversely, not all the currently applied rendering is physically truthful. Much of the wealth of visualization techniques is proprietary to the movie or game industry, and thus not published. As a consequence, what is taught at Universities is not necessary at the forefront of the graphics industry.

Despite increasing computational power and speed, we are still far away from real time dynamics or rendering. More research is needed in the area of physically truthful visualizations. Computations required for a visual simulation can take several hours requiring two phases: (a) calculations, and (b) production of "movies" (using the results of the calculations). With the increase of CAD visualizations for industrial product development, a range of shortcuts has emerged. For a visualization on a 2D computer screen, it is often not necessary to know the details of ongoing physical details. A selection of such cases will then be presented in the full paper. Here are two examples:

Elasticity and Plasticity. It depends on the material itself whether it changes shape temporarily (elastic) or permanently (plastic) after a force is being applied. This has successfully been modelled as a set of springs. One still requires doing the complete

static analysis of the forces, but this domain is much simpler and faster to model than Finite Element Analysis.

Control of Unsynchronized Motion Dynamics. This topic deals with ways of filtering visual information, retaining physically truthful mapping. Problems arise in time scaled visualizations. For example, a gear or rotor blades may be spinning very fast, so fast that they appear to our eyes as rotating in the opposite direction. While this effect is well known, and is no problem in games, it becomes a problem in a virtual prototyping environment, when mimicking the operation of equipment being designed. The trivial solution is downscaling in time to slow motion. This does not work when we have asynchronous events being displayed, e.g. one very fast, and one very slow, because the slow one would come to a stand-still or be distorted. The relative movements between the two bodies may no longer truthful.