Project Light+Sound Simulation, handed in on March 5, 2009.

Title “Coupled Simulation of Light and Sound Propagation in Complex Scenes”

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Summary

This project will investigate methods to simultaneously compute light transport and sound propagation in geometrically complex scenes using massive parallel architectures, such as GPU clusters. Highest degrees of immersion in virtual reality applications, e.g. in virtual prototyping scenarios, can only be achieved when both sound and light are computed physically correct and accurate. A coupled simulation allows sharing of scene data representations but requires novel algorithms that exploit the similarities of both phenomena, as well as novel ways to distribute such computations across many GPUs. Besides basic simulation-oriented research at the interface of research areas E (visualization) and F (hybrid HPC architectures) the proposed project will contribute to a demonstrator for the virtual prototyping vision of SimTech by exploiting the new SimTech GPU cluster and the associated VISUS display technologies as well as opening opportunities for additional collaboration between computer science and other FEM-based projects.

The simulation of light transport in geometrically complex scenes is still a challenging problem in computer graphics. Research in acoustics simulation – at first glance sound seems very different from light – exhibits surprisingly many parallels to light simulation. This becomes apparent as in both areas ray tracing methods, and finite element methods (FEM) have been used.

FEMs for light transport and boundary element methods (BEMs) for sound propagation are a promising combination for a coupled simulation as both require a discretization of the surfaces only. The recent “antiradiance” [1] work in global illumination enables efficient lighting simulation on parallel hardware for the first time, and is similar to fast multipole BEMs in terms of solving strategies and requirements concerning the discretizations.

In order to achieve these goals an adequate programming interface or middleware to GPU clusters, including concepts to handle latencies, data and control flow, has to be designed. Further, special algorithms are required to partition the simulation task for highly parallel computation.