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Keynote

Computer Graphics for Fabrication

Sylvain Lefebvre

Abstract
3D printing and digital fabrication in general empowers us with the ability to create tangible objects from virtual, digital models. The cost and availability of these technologies make them already available to anyone; and the great promise behind this trend is to let anyone design and fabricate objects fitting their needs exactly.

Unfortunately, we are still quite far from this goal: modeling in the virtual space already requires a strong expertise of CAD softwares, but modeling for fabrication is made even more difficult by the requirements (and limits) of the print process and the unforgiving rules of physics. This gets even more complex when trying to design functional parts and mechanisms. In this talk I will show our latest results in trying to simplify the modeling, but also the printing pipeline, using techniques from Computer Graphics. I will describe our software for fabrication, IceSL, and how we use it to help users print more reliably, and to let them easily (and interactively) customize complex objects. I will also introduce latest results in by-example modeling, where the algorithm is responsible for dealing with the intricacies of creating a printable object, while the user focuses on the fun and creative parts of the design.

Short Biography
Sylvain Lefebvre is the lead researcher for the ShapeForge project, which investigates ways to make 3D modeling more accessible in the context of 3D printing. He contributed novel algorithms in this context, from balancing shapes prior to fabrication to the by-example synthesis of printable objects. He also investigates ways to improve 3D printing quality through software only, e.g. through better slicing, better support structures and improved toolpath planning. Sylvain initiated the IceSL modeling/slicing software which now supports several research projects within the team and outside. Sylvain completed his PhD in 2004, joined Microsoft Research (Redmond, USA) as a postdoctoral researcher during the year 2005, and joined Inria in 2006.

Keynote

GPGPU Techniques and Monte Carlo Methods in Tomography Reconstruction

László Szirmay-Kalos

Abstract
Tomography is the inverse problem of rendering. While in rendering a volume is projected onto a camera, in tomography we have to reconstruct a volumetric distribution from projections. Inverse problems are often solved iteratively, i.e. an estimate is projected and the projection is compared to the measured data. Then, depending on the differences, the estimate is corrected and the same process is repeated. In order to avoid overfitting to the measurement noise, regularization is used, which means the incorporation of a-priori information in the correction phase. In this talk we address Positron Emission Tomography (PET), where projections are computed with physically based simulation. In this sense, PET is like an iteratively executed volumetric global illumination simulation, but there are a few important differences. Unlike light photons, gamma photons have high energy and frequency, which are altered by scattering, so simulation cannot be restricted to a few representative frequencies like in rendering. In a PET camera, the role of a pixel is played by a Line Of Response (LOR). There is no focal point but the number of LORs can be around a billion, so efficient parallel algorithms are even more important than in light photon rendering. Starting with the review of PET physics, we address the efficient GPU based Monte Carlo simulation of phenomena like positron range, multiple scattering and absorption in the body (dynamic object) and in detectors (static object). We show how multiple importance sampling can reduce error and Woodcock tracking can handle inhomogeneous media without slow ray marching. As in iterative reconstruction the simulation is executed many times, it is also worth reusing data from earlier simulation steps, which allows the reduction of the required number of samples in a single iteration. Finally, we talk about regularization and post processing, which can further improve accuracy using additional information. The presented methods are demonstrated with reconstruction data obtained with small animal (pre-clinical) PET/CT and also with human PET/CT.

Short Biography
László Szirmay-Kalos was graduated from the Budapest University of Technology and Economics in 1987 as an electrical engineer. He received computer science PhD in 1992 and Doctor of Science degree in 2001 from the Hungarian Academy of Sciences. His research has mainly concentrated on global illumination rendering, Monte Carlo methods, GPU based lighting effects, Non-photorealistic rendering, Physical simulation on GPUs, and Medical imaging. He has been a full professor at the Budapest University of Technology since 2001. He spent several semesters as a guest researcher or lecturer in Ricoh (Japan), University of Minnesota (USA), University of Girona (Spain), Technical University of Vienna (Austria), and Aalto University (Finland), and worked on industrial and research projects for Intel, Hewlett-Packard, Zinemath, and Mediso, where he leads the team developing the GPU cluster based Positron Emission Tomography reconstruction system, called Tera-tomo. He is the author of 10 books and about 300 scientific publications in computer graphics, serves as an associate editor of Computers and Graphics, and acted as the IPC co-chair of the Eurographics Conference twice. He was elected to be the Fellow of Eurographics in 2008.