

CS 3020: November 18, 2014

Speaker: Cem Yuksel

Title: Developing Efficient Graphics Technologies

Abstract:

As we try to build virtual representations for more and more complicated environments in graphics, computational efficiency often becomes the determining factor in how useful a particular graphics technique is in practice. In this talk I will present my approach for developing efficient graphics technologies, which consists of three steps: visual analysis of the subject physical phenomenon, understanding of the physical models that describe the phenomenon, and devising algorithms that fit well to the target computer hardware. The visual analysis helps separate the phenomenon into its visual components and identify which one of these components have deterministic behavior, while understanding the physical models makes it possible to propose simpler models that properly approximate the important visual components. Finally, efficient algorithms can be developed for simplified physical models considering the architectural strengths of the desired computer hardware.

I will explain how this approach helped in developing efficient technologies by presenting three separate research topics as examples: water simulation, realistic hair rendering, and cloth modeling. For water simulation I will talk about the wave particles method for real-time simulation of water surface waves. The wave particles method can achieve about 6 orders of magnitude speed up as compared to the most efficient full fluid simulations in graphics. As a result, scenes with very high complexity can be simulated with high frame rates. As for hair rendering, I will present the dual scattering method for approximating multiple scattering of light in human hair. Multiple scattering plays a crucial role in defining the perceived color of hair and a physically based computation of multiple scattering is important for generating realistic hair images. While previous methods required hours to compute multiple scattering for a single hair image, the dual scattering method can properly approximate the same computation at real-time frame rates with high visual accuracy. Finally, I will talk about the stitch meshes approach for cloth modeling with yarn-level detail, which allowed realistic modeling of knitted garments with unprecedented detail.