Advanced Real-Time Rendering in 3D Graphics and Games

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Lecturers:

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About This Course

Advances in real-time graphics research and the increasing power of mainstream GPUs has generated an explosion of innovative algorithms suitable for rendering complex virtual worlds at interactive rates. This course will focus on recent innovations in real-time rendering algorithms used in shipping commercial games and high end graphics demos. Many of these techniques are derived from academic work which has been presented at SIGGRAPH in the past and we seek to give back to the SIGGRAPH community by sharing what we have learned while deploying advanced real-time rendering techniques into the mainstream marketplace.

Prerequisites

This course is intended for graphics researchers, game developers and technical directors. Thorough knowledge of 3D image synthesis, computer graphics illumination models, the DirectX and OpenGL API Interface and high level shading languages and C/C++ programming are assumed.

Topics

Examples of practical real-time solutions to complex rendering problems:

- Increasing apparent detail in interactive environments
  - Inverse displacement mapping on the GPU with parallax occlusion mapping
  - Out-of-core rendering of large datasets
- Environmental effects such as volumetric clouds and rain
- Translucent biological materials
- Single scattering illumination and approximations to global illumination
- High dynamic range rendering and post-processing effects in game engines

Suggested Reading

- Real-Time Rendering by Tomas Akenine-Möller, Eric Haines, A.K. Peters, Ltd.; 2nd edition, 2002
- Advanced Global Illumination by Philip Dutre, Phillip Bekaert, Kavita Bala, A.K. Peters, Ltd.; 1st edition, 2003
- Radiosity and Global Illumination by François X. Sillion, Claude Puech; Morgan Kaufmann, 1994.
- Physically Based Rendering : From Theory to Implementation by Matt Pharr, Greg Humphreys; Morgan Kaufmann; Book and CD-ROM edition (August 4, 2004)
- The RenderMan Companion: A Programmer's Guide to Realistic Computer Graphics, Steve Upstill, Addison Wesley, 1990.
- Advanced RenderMan: Creating CGI for Motion Pictures, Tony Apodaca & Larry Gritz, Morgan-Kaufman 1999.
- Texturing and Modeling, A Procedural Approach Second Edition, Ebert, Musgrave, Peachey, Perlin, Worley, Academic Press Professional, 1998.
- ShaderX3: Advanced Rendering with DirectX and OpenGL, by Wolfgang Engel (Editor), Charles River Media, 1st edition (November 2004)
- ShaderX4: Advanced Rendering Techniques, by Wolfgang Engel (Editor), Charles River Media, 1st edition (November 2005)
- ShaderX2: Introductions and Tutorials with DirectX 9.0, by Wolfgang Engel (Editor), Wordware Publishing, Inc.; Book and CD-ROM edition (November 2003)
- ShaderX2 : Shader Programming Tips and Tricks with DirectX 9.0, by Wolfgang Engel (Editor), Wordware Publishing, Inc.; Book and CD-ROM edition (November 2003)

Lecturers

Natalya Tatarchuk is a staff research engineer in the demo group of ATI's 3D Application Research Group, where she likes to push the GPU boundaries investigating innovative graphics techniques and creating striking interactive renderings. Her recent achievements include leading creation of the state-of-the-art realistic rendering of city environments in ATI demo “ToyShop”. In the past she has been the lead for the tools group at ATI Research. She has published articles in technical book series such as ShaderX and Game Programming Gems, and has presented talks at Siggraph and at Game Developers Conferences worldwide. Natalya holds BA's in Computers Science and Mathematics from Boston University and is currently pursuing a graduate degree in CS with a concentration in Graphics at Harvard University.

Chris Oat is a senior software engineer in the 3D Application Research Group at ATI where he explores novel rendering techniques for real-time 3D graphics applications. As a member of ATI's demo team, Chris focuses on shader development for current and future graphics platforms. He has published several articles in the ShaderX and Game Programming Gems series and has presented at game developer conferences around the world.

Jason L. Mitchell is a software developer at Valve Software, where he works on integrating cutting edge graphics techniques into the popular Half-Life series of games. Prior to joining Valve in 2005, Jason worked at ATI in the 3D Application Research Group for 8 years. He received a BS in Computer Engineering from Case Western Reserve University and an MS in Electrical Engineering from the University of Cincinnati.

Alex Evans started his career in the games industry writing software renderers for innovative UK game developer Bullfrog; after completing a degree at Cambridge University he joined Lionhead Studios full time as one of the lead 3D programmers on the hit game 'Black & White'. His passion is the production of beautiful images through code - both in games, such as Rag Doll Kung Fu and Black & White, but also through his work (under the name 'Bluespoon') creating real-time visuals for musicians such as Aphex Twin, Plaid and the London Sinfonietta.

Carsten Wenzel is a software engineer and member of the R&D staff at Crytek. During the development of FAR CRY he was responsible for performance optimizations on the CryEngine. Currently he is busy working on the next iteration of the engine to keep pushing future PC and next-gen console technology. Prior to joining Crytek he received his M.S. in Computer Science at Ilmenau, University of Technology, Germany in early 2003. Recent contributions include GDC(E) presentations on advanced D3D programming, AMD64 porting and optimization opportunities as well articles in *ShaderX 2*.

Pedro V. Sander is a member of the 3D Application Research Group of ATI Research. He received his Bachelors degree from Stony Brook University, and his Masters and PhD in Computer Science at Harvard University. Dr. Sander has done research in geometric modeling, more specifically efficient rendering techniques and mesh parameterization for high quality texture mapping. At ATI, he is researching real-time rendering methods using current and next generation graphics hardware.

Contents

Preface

Welcome to the Advanced Real-Time Rendering in 3D Graphics and Games course at SIGGRAPH 2006. We've included both 3D Graphics and Games in our course title in order to emphasize the incredible relationship that is quickly growing between the graphics research and the game development communities. Although in the past interactive rendering was synonymous with gross approximations and assumptions, often resulting in simplistic visual rendering, with the amazing evolution of the processing power of consumer-grade GPUs, the gap between offline and real-time rendering is rapidly shrinking. Real-time domain is now at the forefront of state-of-the-art graphics research – and who wouldn't want the pleasure of instant visual feedback?

As researchers, we focus on pushing the boundaries with innovative computer graphics theories and algorithms. As game developers, we bend the existing software APIs such as DirectX and OpenGL and the available hardware to perform our whims at highly interactive rates. And as graphics enthusiasts we all strive to produce stunning images which can change in a blink of an eye and let us interact with them. It is this synergy between researchers and game developers that is driving the frontiers of interactive rendering to create truly rich, immersive environments. There is no greater satisfaction for developers than to share the lessons learned and to see our technologies used in ways never imagined.

This is the first time this course is presented at SIGGRAPH and we hope that you enjoy this year's material and come away with a new understanding of what is possible without sacrificing interactivity! We hope that we will inspire you to drive the real-time rendering research and games!

Natalya Tatarchuk, ATI Research, Inc.
April, 2006