Interactive Walkthrough of Large Geometric Databases

Course Notes for SIGGRAPH ’96

Course Organizer

Eric L. Brechner
Microsoft Corporation

Course Speakers

Brian Cabral
Silicon Graphics Inc.

Ned Greene
Apple Computer

Jarek Rossignac
IBM T.J. Watson Research Center

Thomas A. Funkhouser
AT&T Bell Laboratories

Abstract

This course will focus on techniques, algorithms, data-structures, and databases for displaying very large geometric databases interactively (greater than one million polygons drawn at least ten frames per second). Beginning with a discussion of basic techniques and leading to state-of-the-art algorithms, the speakers will address key issues in walkthrough, including visibility computations, automatic object simplification, and memory management through database subset pre-fetching. Speakers will show real applications of these algorithms to a variety of areas, including visual simulation, virtual reality, architecture, and digital mockup.

Attendees of this course will better understand the key issues in dealing with very large geometric databases. They will be provided basic and state-of-the-art techniques to overcome hardware and software limitations that preclude the high frames rates necessary for interactive inspection of complex geometric scenes. These techniques will be illustrated by real examples of working walkthrough applications using databases with between 1 million and 500 million polygons.

A working knowledge of interactive computer graphics, including the mechanisms of matrix transformation, perspective, and raster graphics, will form a good foundation for the course material.

Course Schedule

A. Introduction - 10 minutes

Statement of the problem. Introduction of the speakers. Agenda. - Eric Brechner

B. Graphics Techniques for Walkthrough Applications - 75 minutes

An introduction to techniques common to most walkthrough applications with examples from the IRIS Performer toolkit. The methods include multi-tasking, view frustum culling, occlusion culling, level-of-detail, frame rate control, database paging, dynamic primitive tesselation, and texture replacement. - Brian Cabral

- **Morning Break**

C. Hierarchical Visibility and Tiling - 75 minutes

Hierarchical approaches to accelerating visibility computations in extremely complex scenes. - Ned Greene

- **Lunch**

D. Geometric Simplification - 75 minutes

The generation and exploitation of multi-resolution graphic models for the interactive visualization of complex mechanical or architectural 3D scenes. - Jarek Rossignac

- **Afternoon Break**

E. Database Management - 75 minutes

Algorithms for computing and pre-fetching a small subset of a disk-resident database to store in memory during an interactive walkthrough. - Thomas Funkhouser

- **Seventh-inning Stretch**

F. Wrap-up and Future Directions - 20 minutes

Hierarchical level of detail, culling, and data staging for interactive walkthrough of infinite databases. - Eric Brechner

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About the speakers

Eric L. Brechner
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Eric Brechner is a member of the Media Foundation group at Microsoft. He was formally a Senior Principal Scientist at The Boeing Company where he worked in the areas of large scale visualization, computational geometry, network communications, dataflow languages, and software integration. He was the principal architect of FlyThru™, the walkthrough program for the 20GB, 500+ million polygon model of the Boeing 777 aircraft, authoring three invention disclosures relating to that work. Before coming to Boeing, Eric had worked in computer graphics and CAD for Silicon Graphics Inc., GRAFTEK, the Rensselaer Design Research Center (formally the Center for Interactive Computer Graphics), and the Jet Propulsion Laboratory. He holds a BS and MS in mathematics, and a PhD in applied mathematics from Rensselaer Polytechnic Institute.

Brian Cabral
Member Technical Staff
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Brian Cabral is a member of the Core Rendering technical staff within the Advanced Graphics Division at Silicon Graphics Computer Systems. His current technical focus is on Perfomer™based large geometric database walkthrough software and tools. Previously, Brian, developed alogorithms and techniques in the areas of Medical visualization and image processing, scientific visualization, and physical based shading and lighting. Prior to working at SGI, Brian, was a lead engineer and researcher at Lawerence Livermore National Laboratory where he worked a variety of visualization algorithms, tools and systems. He received a BS in computer science from California State University Stanislaus and a MS in computer science from University of California, Davis. His intrests include differential geomtry, image processing, shading techniques, computational geometry and signal processing. When he's not toiling over a large equation or

chunk of code Brian enjoys the good life of California.

Ned Greene

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Ned Greene is a member of the Advanced Technology Group at Apple Computer in Cupertino, California, where he conducts research in computer graphics. He holds a PhD in computer science from the University of California at Santa Cruz. From 1980 to 1989 Ned worked at the Computer Graphics Lab at The New York Institute of Technology where he developed software for computer animation and contributed to pioneering animation projects suchs as The Works and The Magic Egg. Over the years he has been a frequent contributor to the SIGGRAPH technical program and Electronic Theatre.

Jarek Rossignac
Senior Manager
IBM T.J. Watson Research
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Jarek Rossignac is Senior Manager of the 3D Graphics and Interactions Department at IBM Research, covering a wide range of activities in CAD, graphics, and virtual reality. He joined IBM Research in 85 with a PhD in EE on Solid Modeling from the University of Rochester. In 89, he created the Interactive Geometric Modeling group and managed research projects in topological representations and algorithms for CAD and in the interactive design and inspection of complex animated assemblies. He published over 40 papers winning three Best Paper external awards (Computer and Graphics'90, Eurographics'91, and IEEE Computer Graphics and Applications'93). He authored 12 invention disclosures in modeling and graphics and received numerous IBM internal awards (including the Best Paper award from Computer Science and a Research Division Award for the 3D Interaction Accelerator software system, which supports graphics and VR interactions with 3D CAD models of industrial complexity, i.e.: comprising millions of faces). Rossignac lectures at SIGGRAPH and at Eurographics. He is Associate Editor of four professional journals (ACM Transactions on Graphics, Computer-Aided Design, The Visual Computer, and Computer Graphics Forum) and Guest Editor for 7 special issues (three in Computer-Aided Design, one in the International Journal of Computational Geometry and Applications, two in the IEEE Computer Graphics and Applications, and one in the ACM transactions on Graphics). He refereed several hundred manuscripts and numerous grant proposals, serves in various international conference committees (including Eurographics 91-93-94 and SIGGRAPH 93-94). Rossignac is also co-chairman of the ACM/SIGGRAPH Sym-

[1] Jarek Rossignac is now Director of the Graphics Visualization and Usability Center, Georgia Institute of Technology, College of Computing, Atlanta, GA 30332-0280, *rossignac@cc.gatech.edu*

posium on Solid Modeling for 91-95, of the Eurographics'94 Workshop on Graphics Hardware. He is co-chairman of the International Program Committees for Eurographics'96 and for CAD/Graphics'95. Finally, He serves as Program Director for SIAM's Activity Group on Geometric Design.

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Thomas Funkhouser is a member of the technical staff at AT&T Bell Laboratories. His research interests include multi-user systems, global illumination, and algorithms for managing large amounts of three-dimensional data in interactive computer graphics and visualization systems. He is a principal developer of the UC Berkeley Architectural Walkthrough System which is able to maintain thirty frames per second during interactive visualization of a building model containing 1.5 million polygons. He received a B.S. in biological sciences from Stanford University in 1983, a M.S. in computer science from UCLA in 1989, and a PhD in computer science from UC Berkeley in 1993.